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DISTRO II-DISTRIBUTION ROTATION MODEL

Joanne M. Witt

Army Research Institute for the Behavioral
and Social Sciences
Arlington, Virginia

April 1973

Technical Research Report 1176

AD

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Joanne M. Witt

Pauline T. Olson, Work Unit Leader

U. S. Army

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13. ABSTRACT

In a continuation of effort under an operations research requirement, the Statistical Research and Analysis Division, BESRL has been engaged in study and evaluation of the Army's personnel system through development of a model enabling Army personnel management to assess quantitatively the impact of policies on deployment and readiness. The present report deals with the development and use of DISTRO-II (Distribution Rotation model), essentially a modification of the General Matrix Manipulator (GMM), a previous BESRL model. DISTRO-II, which simulates additional factors affecting personnel distribution, more accurately models deployability characteristics of the Army than does either the GMM or DISTRO-I.

The DISTRO-II model is described in the management section of the report. Principles of the GMM and its interface with DISTRO II are presented in detail in the technical supplement section. FORTRAN listings of DISTRO2 subroutines are provided in the appendix.

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Resources						
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Matrices						
Interface						

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Joanne M. Witt

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STATISTICAL RESEARCH AND ANALYSIS DIVISION
Cecil D. Johnson, Chief

ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

Office, Chief of Research and L .velopment
Department of the Army
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FOREWORD

The research reported here was accomplished by the U. S. Army Research Institute for the Behavioral and Social Sciences (ARI). The Institute, established 1 October 1972 as replacement for the U. S. Army Manpower Resources Research and Development Center, unifies in one enlarged organization all OCRD activities in the behavioral and social science area, including those formerly conducted by the Behavior and Systems Research Laboratory (BESRL) and the Motivation and Training Laboratory (MTL).

The present Technical Research Report was prepared while BESRL existed as a separate entity and reflects Division and Work Unit structure as constituted prior to 1 October 1972.

The Work Unit "Simulation Models of Personnel Operations II--SIMPO" was a continuation of effort under an operations research requirement described in the Army Master Study Program under the title "A Simulation Model of Personnel Operations (SIMPO) and is Project 2Q065101M746 (FY 1972), "Army Operations and Intelligence Analysis"under the auspices of the Army Study Advisory Committee.

The present Technical Research Report deals with the development and use of DISTRO-II, a major modification of a previous BESRL model, the General Matrix Manipulator. DISTRO-II, which simulates additional factors affecting personnel distribution, can assist management by more accurately predicting the effects of selected policy-related nondeployability factors.

J. E. UHLANER
Technical Director

BRIEF

Requirement:

To develop a model enabling Army personnel management to assess quantitatively the impact of personnel policies on deployment and readiness of personnel.

Research Product:

The DISTRO-II model, essentially a modification of the General Matrix Manipulator for use in distribution problems, was developed to calculate deployability characteristics of the Army through simulation of priority groups and distribution areas, and the differential deployability of personnel in three categories: 1) NOS—not deployable overseas—available for CONUS assignment only; 2) NST—not deployable to short tour—available for CONUS and long tour assignments; and 3) IAV—not restricted—generally available for assignment.

The DISTRO-II model expands the capability of the General Matrix Manipulator in the following ways:

1. Broadens the model's concept of policy-caused nondeployability

2. Relates the world-wide availability of personnel to tour area manning levels

3. Extends simulation to priority groups

4. Fills tour area requirements in advance

DISTRO II—DISTRIBUTION ROTATION MODEL

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DISTRO II—DISTRIBUTION ROTATION MODEL

BACKGROUND

The Deployability Problem

Projecting the Army's distribution capabilities—its ability to provide qualified men for specific jobs at an appropriate time and location—is a difficult task for management. For many years, Army management has estimated its distribution capabilities primarily as a function of two variables: 1) the number of job vacancies and 2) the number of men qualified to fill these vacancies. At best, estimates based on these data are crude approximations of reality. Many other factors restrict the deployment of qualified men to the particular jobs where they are needed. As long as the Army closely resembles a steady state system, with losses equaling replacements and authorizations remaining relatively constant, discount factors can approximate the effects of inhibiting or nondeployability factors and the estimates are within acceptable limits. However, when drastic dynamic changes such as the buildup and subsequent phase-down of forces in Vietnam begin to occur in the military setting, the crippling effects of policy-caused nondeployability skyrocket. It becomes very difficult to estimate accurately the impact of rapid turnover and frequent policy change on personnel deployment and readiness. Estimation methods which take into account more of the distribution restraints are needed.

Personnel deployment and readiness in the Army, as in other personnel systems, are a function of two major factors: 1) *requirements* relating system constraints and policy considerations, and 2) personnel *resources* reflecting characteristics of individuals in the system. These requirements and resources often appear well-balanced, whereas in reality several variables such as rotation policies and tour area needs may interact to reduce drastically the pool of deployable personnel. The problem for management is basically one of matching available resources with system requirements while allowing all relevant constraints to interact realistically.

Any change in the nature of military conflict may cause differential losses due to deaths, injuries, prisoners of war, or retirements. In turn,both position vacancies and the number of men qualified to fill the vacancies are affected. Rapid turnover caused by limiting combat service to a few months or by requiring only two years' involuntary military service arouses major cost considerations relating to training and travel between assignments.

Management's values may also affect the nondeployability of personnel. Management sets priorities including which assignments should be stabilized for system efficiency, which vacancies should be filled first, or which policies are the most expedient. After such decisions have been made, characteristics of the individuals in the system may still alter the picture considerably. It may be too costly to assign men with short expected termination of service (ETS) dates to new positions. Available personnel may not possess appropriate skills and therefore have to be retrained. In order to continue high morale among troops, individual rights must also be guarded, and consistent predictable policies carried out with respect to limiting the number of combat area assignments, minimizing time in a combat zone, or allowing accompanied tours between combat assignments. All these factors interact causing tension between requirements and resources.

Although computer models previously developed by the Behavior and Systems Research Laboratory (BESRL) are not specifically designed to handle nondeployability, they use several techniques which partially reflect the deployability capabilities of the Army. One of the earliest techniques used in the mass flow models discounted personnel inventories by a factor representing transients, patients, prisoners, and students (TPS). Later models approach the problem more directly by representing specific types of nondeployability. For example, some models maintain separate nodes for stabilized assignments, combat tour returnees, and other special categories of personnel. Simulation models may also represent delays between system entry and assignment as well as monitor estimated termination of service. Systems analysts emphasize careful design of assignment rules to faithfully incorporate system constraints. All these methods are helpful, but management needs a more comprehensive evaluation of the nondeployability problem. It needs to meaningfully relate management policies, system variables, and individual characteristics so that more nondeployability factors can be accounted for.

REQUIREMENT FOR DISTRO II MODEL

The Program to Improve Management of the Army Resources (PRIMAR) Project 5-1, "Developing Techniques for Assessing the Impact of Personnel Policies on Deployability," expressed management's concern about non-deployability. An explicit goal of this project was the development of procedures for quantitatively assessing the impact of personnel policies on deployment and readiness. A special team of the SIMPO I Steering Committee was assigned to monitor an adaptation of the General Matrix Manipulator (GMM) to cover policy-caused nondeployability.[1] The GMM was selected because it is a matrix-based computer model which tracks both time in the system and time in the tour for all personnel. Also, reassignment flow rules can easily be input and changed by the user at the time of execution. The two time dimensions, as well as the rotation rules, are important factors affecting the deployability of personnel. Staff Officers of the Capabilities and Analysis Division, Directorate of Procurement and Distribution, Office of the Deputy Chief of Staff for Personnel (DCSPER-CAD), agreed to work with BESRL in developing a problem in which interactions between rotation and assignment processes and other nondeployability factors could be examined.

BESRL's initial response to the PRIMAR requirement was the SIMPO I Distribution-Rotation Model (DISTRO I), an adaptation of the GMM to the deployability problem.[2] Within the original GMM framework, DISTRO I subroutines distribute personnel in the GMM tour areas to command elements. At the end of the simulation, all nontransients within a given tour area, following discounting for TPS, are distributed to command elements proportionately to command element authorizations.

Although DISTRO I represents nondeployability more accurately than earlier models, it has some limitations. The system's distribution capabilities are not directly related to tour area manning levels during the simulation. The total number of available personnel serves only as a ceiling in determining tour area manning levels. DISTRO I does not consider the world-wide availability of personnel; it distributes each tour area separately without relating it to the total system. Separate distribution of each tour area to command elements is, at best, a fragmented approach.

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[1] Witt, Joanne M. and Adele P. Narva. SIMPO-I General Matrix Manipulator (GMM). Technical Research Report 1165. Behavior and Systems Research Laboratory, Arlington, VA. January 1971.

[2] Witt, Joanne M. SIMPO-I DISTRO--Distribution Rotation Model. Research Memorandum 71-4. Behavior and Systems Research Laboratory, Arlington, VA. September 1971.

DISTRO II MODEL

To more accurately model deployability characteristics of the Army, BESRL scientists with the guidance of DCSPER personnel have developed the DISTRO II Model, a set of subroutine options which significantly modify the GMM. DISTRO II routines calculate deployability indices which interact with the assignment-rotation process throughout the GMM. DISTRO II routines have four major effects on the GMM simulation.

1. They broaden the model's concept of policy-caused nondeployability.

2. They relate the world-wide availability of personnel to tour area manning levels.

3. They extend the GMM simulation to priority groups.

4. They fill tour area requirements in advance.

DISTRO II broadens the definition of deployability in that it accounts for more nondeployability factors than does either the GMM alone or DISTRO I (Figure 1). Personnel matrices in the GMM alone represent all personnel as assets. DISTRO I separates nondeployable transients from deployable assets. Based on time in tour, DISTRO II matrices represent three kinds of personnel: transients, assets, and reassignables, each with its own deployability characteristics. The transients in Figure 1 are those who are reassigned to the area but who are not yet considered assets. Assets are those who are actually in an area and who cannot be reassigned, whereas the reassignables are available for reassignment.

DISTRO II employs the concept of differential deployability. Differential deployability means that a person is deployable with respect to a specific area, e.g., an individual may be deployable to long tour and not to short tour, or to Continental United States (CONUS) and not to long tour. In other words, deployability has meaning only in reference to specific area needs.

In DISTRO II, differential deployability is represented by three categories of personnel availability:

1. NOS—not deployable overseas—available for CONUS assignments only

2. NST—not deployable to short tour—available for CONUS and long tour assignments

3. IAV—not restricted—generally available for assignment

These availability categories reflect restrictions placed on individuals available for reassignment. As each man completes a tour or otherwise becomes available for reassignment, he automatically increases the tally in one of the three availability indices (Figure 2). For example, a few men are stationed in CONUS for recurring tours because of special personal circumstances or because of their unique skills. As each of these men completes a CONUS tour, he adds one to the NOS counter. Most short tour returnees are deployable only to accompanied CONUS and long tour; these men are counted by the NST variable. Others, completing two years in CONUS or the long tour and being eligible for any assignment, are added to the IAV category. The sum of NOS, NST, and IAV equals all personnel available for reassignment at the end of a time period. The three categories encompass most of the restrictions on deployment.

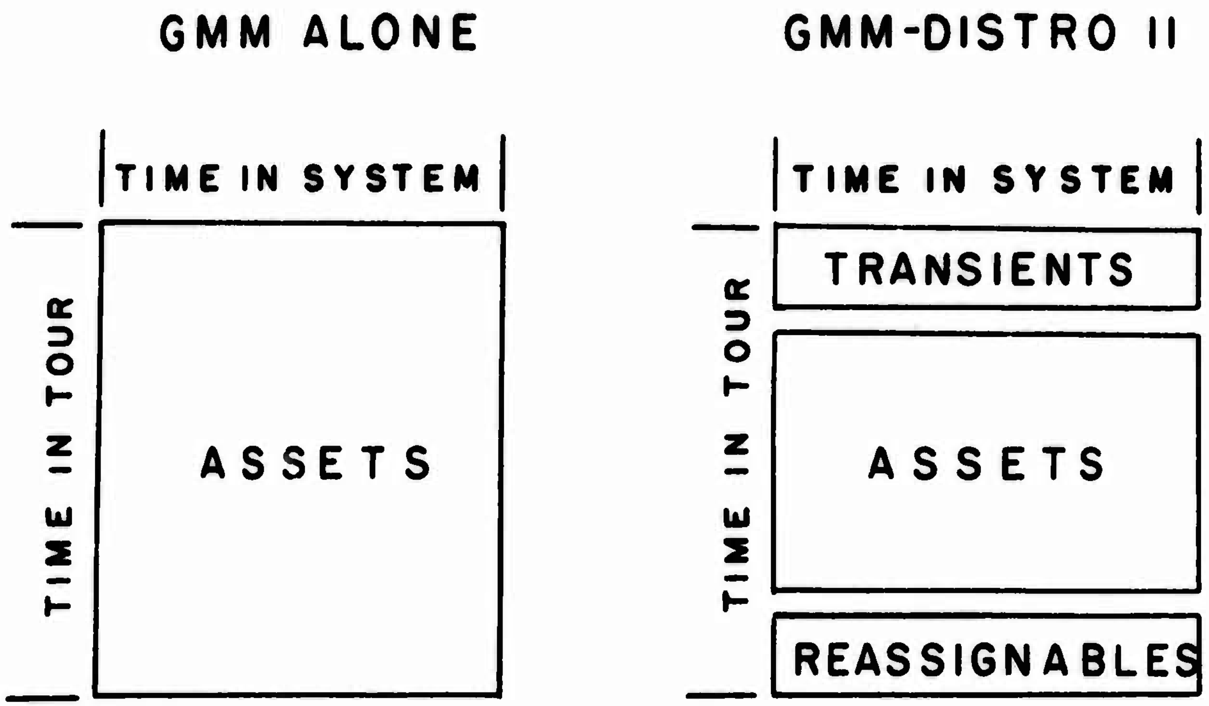

Figure 1. Types of matrices

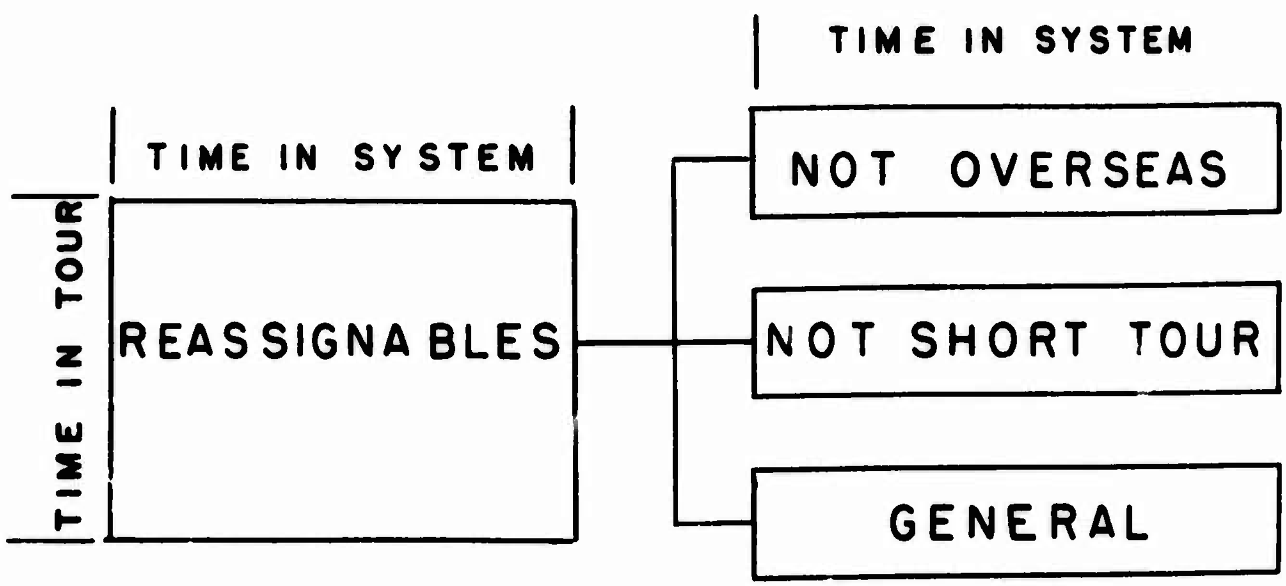

Figure 2. GMM-DISTRO II deployability categories

In the GMM, input to a given tour area is a direct function of that tour area's authorization without consideration of the availability of personnel assets. By applying the DISTRO I options, tour area manning levels are made to reflect the total number available for reassignment. These manning levels, however, ignore differential deployability by assuming that deployable personnel assets can be assigned to any area. Employing DISTRO II options, manning levels in the GMM reflect authorizations, assets, and the number of men available for reassignment to specific areas. To accomplish the best distribution of available personnel to tour areas, DISTRO II first distributes the most restricted group of personnel, NOS, to CONUS. Following the NOS assignments, NST personnel are distributed to CONUS and long tour. Then personnel in the least restricted group, IAV, are distributed among CONUS, long tour, and short tour. This approach prevents filling one tour area to its fully authorized strength only to find that the last tour to be filled has a critical shortage. Since the model initially considers specific availability of personnel in determining manning levels, all tour areas are filled equitably.

Present Army management procedures for utilizing available assets are based on five distribution groups, called priority groups, which are filled relative to their importance to maintaining a maximally efficient military system. The GMM works to fill tour area authorizations without considering priority groups. Employing the DISTRO I routines, tour area personnel are distributed at the end of the simulation into the five priority groups. The priority groups, however, are not considered during the simulation. A new approach was needed to distribute personnel to each of these priority groups across the entire system—not separately within each tour area. Instead of determining how many are needed in the short tour and then saying that N of these will be in priority group 1 as in DISTRO I, management would like to determine how many are available for priority group 1 and then send N of these to short tour. The DISTRO II procedure places major emphasis on filling priority groups across tour areas rather than filling specific tour areas.

The common element linking the GMM simulation matrices to the expanded simulation of priority groups in DISTRO II is the tour area. DISTRO II totals assets within individual tour areas and distributes these assets into five priority groups which are not represented directly by the GMM matrices (Figure 3). DISTRO II subroutines determine how many of the total tour area assets are serving in each priority group within the tour area and how many of the available assets will be assigned to each priority group across all tour areas considering their current assets and authorizations. Tour area manning levels are then recalculated by apportioning new personnel in each priority group to the individual tour areas. These tour area manning levels are used as a driving force in the GMM to reassign personnel. Thus, the distribution process becomes an integral part of the rotation-assignment process within GMM-DISTRO II.

Figure 4 shows how most models, including the GMM, fill requirements. The top priority areas get 100% or maximum fill, the middle priority groups get less, and the low priority areas get what is left over. Often this method results in a critical shortage in one or more areas. It is necessary to maintain a minimum number of men in low priority areas in order that high priority areas can function adequately. Employing the DISTRO II options of determining manning levels based on the total world-wide availability of personnel, all areas can be filled adequately in relation to the total system. The emphasis shifts from tour areas to priority groups, and Figure 5 shows the results. The priority groups are filled in relation to their importance as specified by management.

DISTRO II also directs the GMM to fill requirements one month in advance to allow sufficient travel time for men to reach their destinations. Manning levels for month two are actually filled in month one. The model determines manning levels for month two based on the number of projected assets for month two and the number available for reassignment in month 1. DISTRO II, employing a combination of assignments in advance, differential deployability, and simulation of

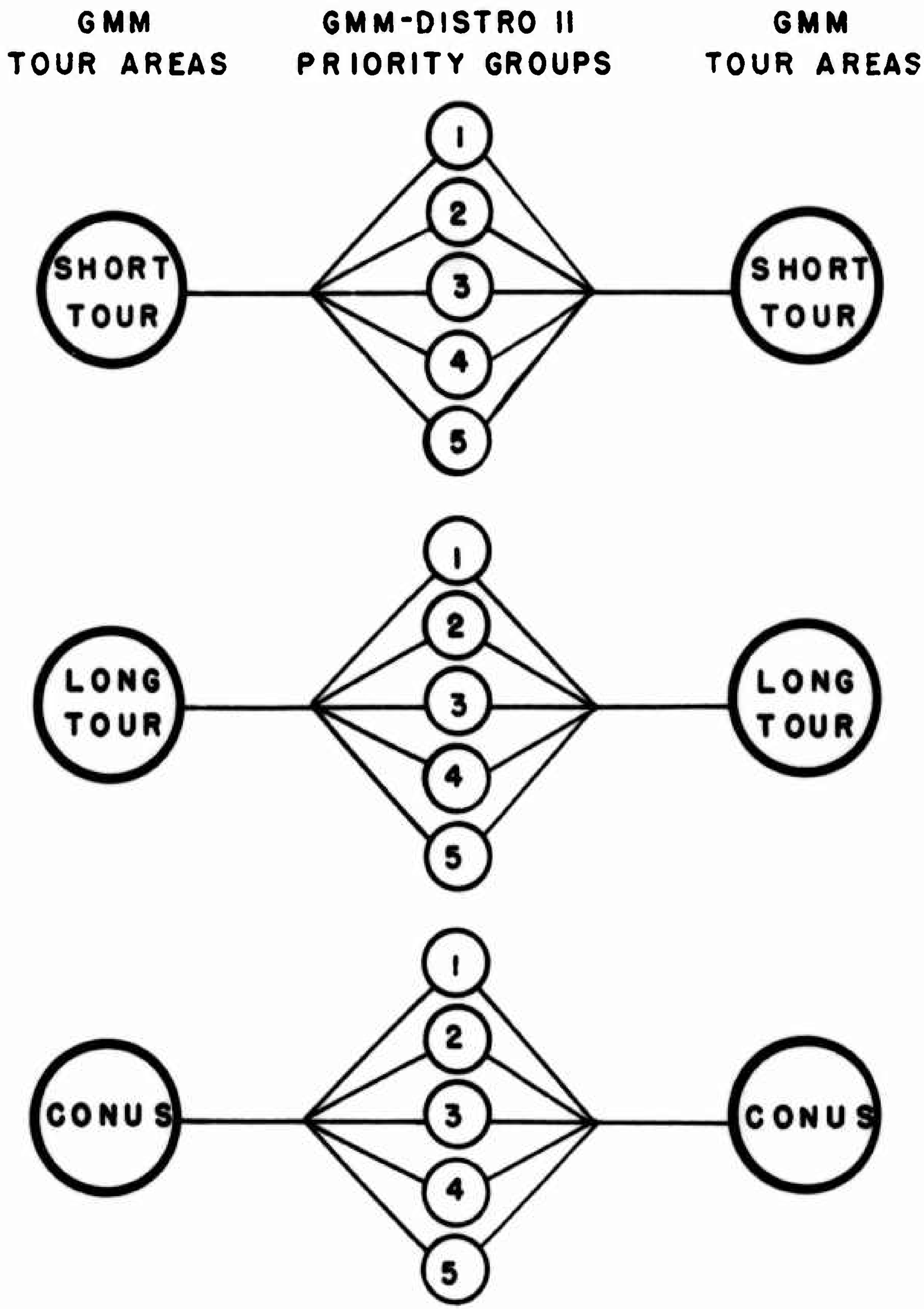

Figure 3. GMM-DISTRO II extension into priority groups

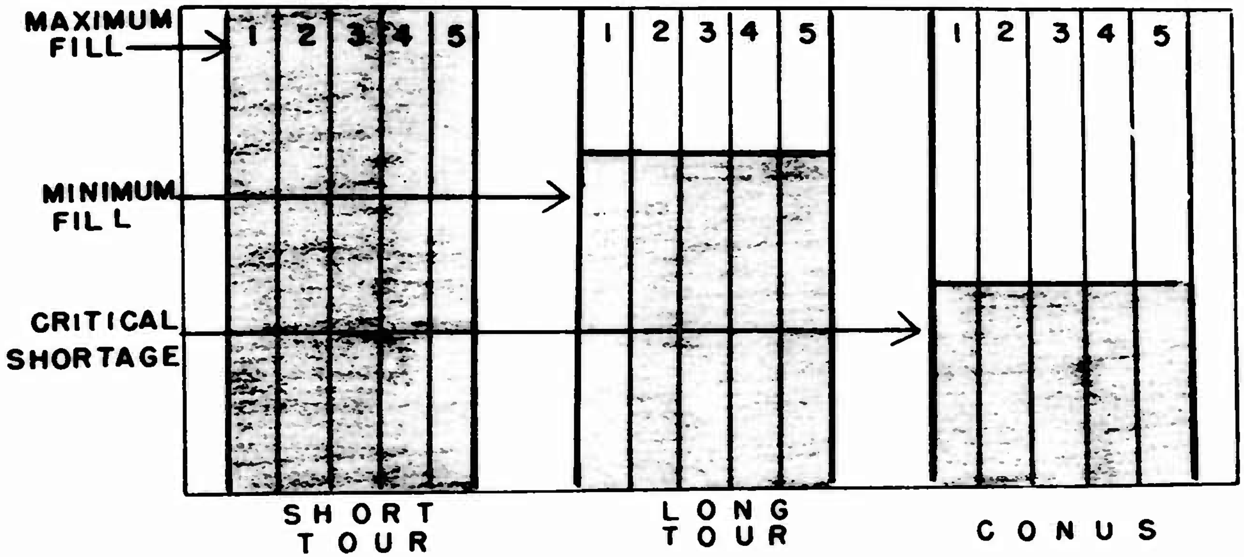

Figure 4. Most models fill tour areas like this

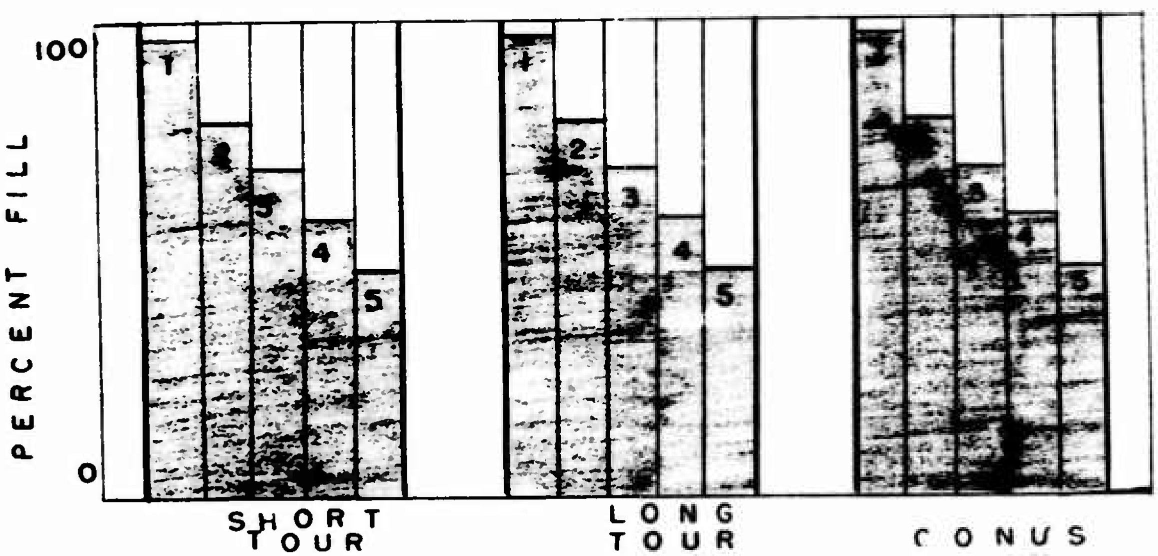

Figure 5. DISTRO II fills tour areas like this

priority groups, coupled with reassignment policies as represented in the GMM--including separate representation of different types of deployable personnel--presents a more realistic picture of policy-caused deployability for management than did previous models.

DISTRO II can be useful to management in problems such as the following:

1. How can management provide more experienced personnel in the short tour? If extended tours are allowed in return for various alternative rotation policies, how many more experienced personnel will be available? At what point in time would the alternative policies become infeasible? If management promotes men faster, at what point does the system have a shortage of men with the minimum qualifications for promotion?

2. What are the best policy alternatives which will limit the number of combat tours for career personnel?

3. What are the effects of allowing more time between assignments?

These and many other questions can be studied with the use of GMM-DISTRO II so that management can better predict the effects of nondeployability factors.

TECHNICAL SUPPLEMENT: PROGRAM DOCUMENTATION

The GMM is a matrix-based mass flow model which simulates rotation policies, skill acquisition, and assignment policies of Army management. Groups of personnel are represented by numbers arranged in two-dimensional matrices such as those in Figure 6. The dimensions may be defined by management as time in service and time in tour or time in service and time in grade. These factors are important for determining the deployability of personnel. Each matrix represents a group of similar individuals, such as 11B1 in the short tour or 11B2 in the long tour.

Movements between these matrices are determined by management policies. These movements represent policies of two types: rotation and promotion (Figure 7). Type 1 flow, simulating promotions, is across skill levels— a horizontal move in which a person's time in tour remains the same while his time in grade moves to the initial position of the next grade. Type 2 simulates reassignments. Movement between commands is from one time in grade and time in tour to the same time in grade and the first time position in another tour. Reassignments can occur at the end of a tour of duty or prior to the end of a tour of duty.

Employing these matrices and flows, the GMM logic is relatively simple (Figure 8). It updates the matrices, calculates assets, determines requirements, uses flow rules to fill these requirements, and then repeats the cycle for each subsequent time period.

INTERFACE OF GMM WITH DISTRO II

DISTRO II options are integrated with the GMM simulation process. Under these options, DISTRO II subroutines gain control to shift the emphasis of the simulation from tour areas to priority groups spanning the tour areas. To accomplish this, the DISTRO II subroutines convert the GMM tour area data to priority group data. The priority group data are manipulated so as to represent distribution processes in the system. They are then reconverted to tour area data. As a consequence, the new tour area data reflect priority group hierarchies and yet are still in a form compatible with the GMM. The GMM then regains control and continues to operate on the tour area data as if it had not been altered. By switching back and forth between GMM and DISTRO II routines, the simulation of matrices representing tour areas and personnel categories is expanded to cover a new dimension of priority groups. This expansion occurs with minimal increase in on-line storage and data preparation. If these priority groups were simulated directly, the number of matrices in the GMM would have to be multiplied by five— one matrix for each priority group would be needed to replace each personnel matrix. For example, instead of one matrix to represent personnel on their first short tour, the GMM alone would require five matrices, one for personnel on their first short tour in each priority group. Besides making the data base massive, flow rules among the matrices would become much more complicated and repetitive.

DISTRO II can be expressed as a series of events interwoven with the GMM. Figure 9 illustrates this integration of GMM and DISTRO II logical events. DISTRO II events are summarized in the following eight steps:

1. Input DISTRO II data

2. Calculate personnel assets

3. Summarize authorizations by distribution or tour areas

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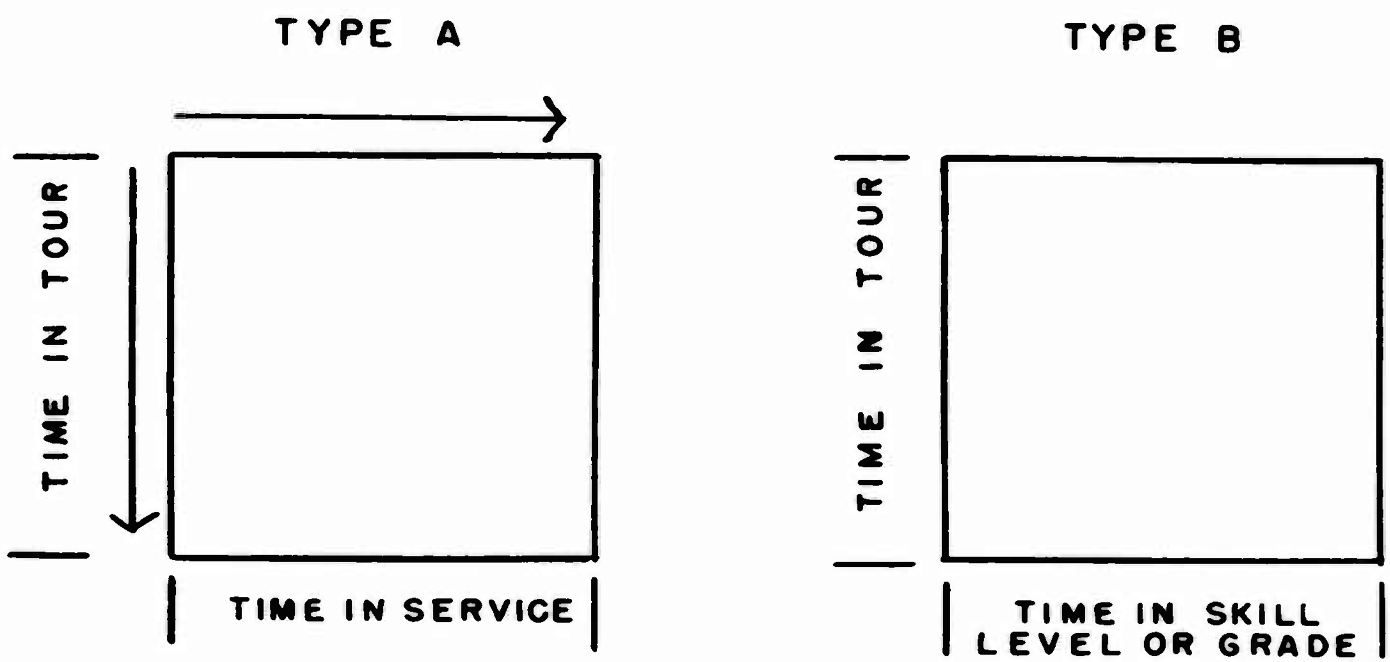
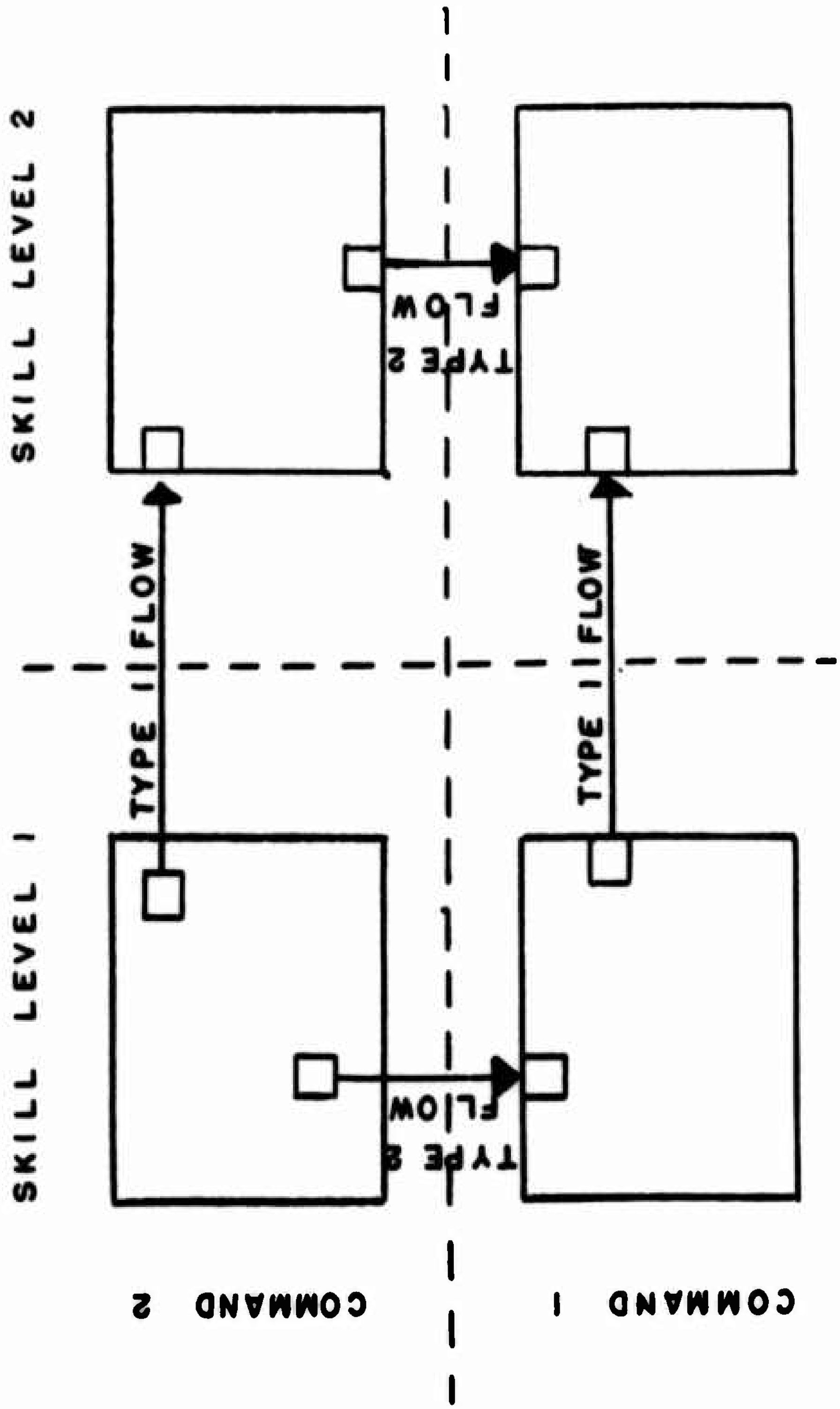


Figure 6. Types of nodes in the GMM


SKILL LEVEL 2
SKILL LEVEL 1
TYPE 1 FLOW
TYPE 1 FLOW
TYPE 2 FLOW
TYPE 2 FLOW
COMMAND 1
COMMAND 2

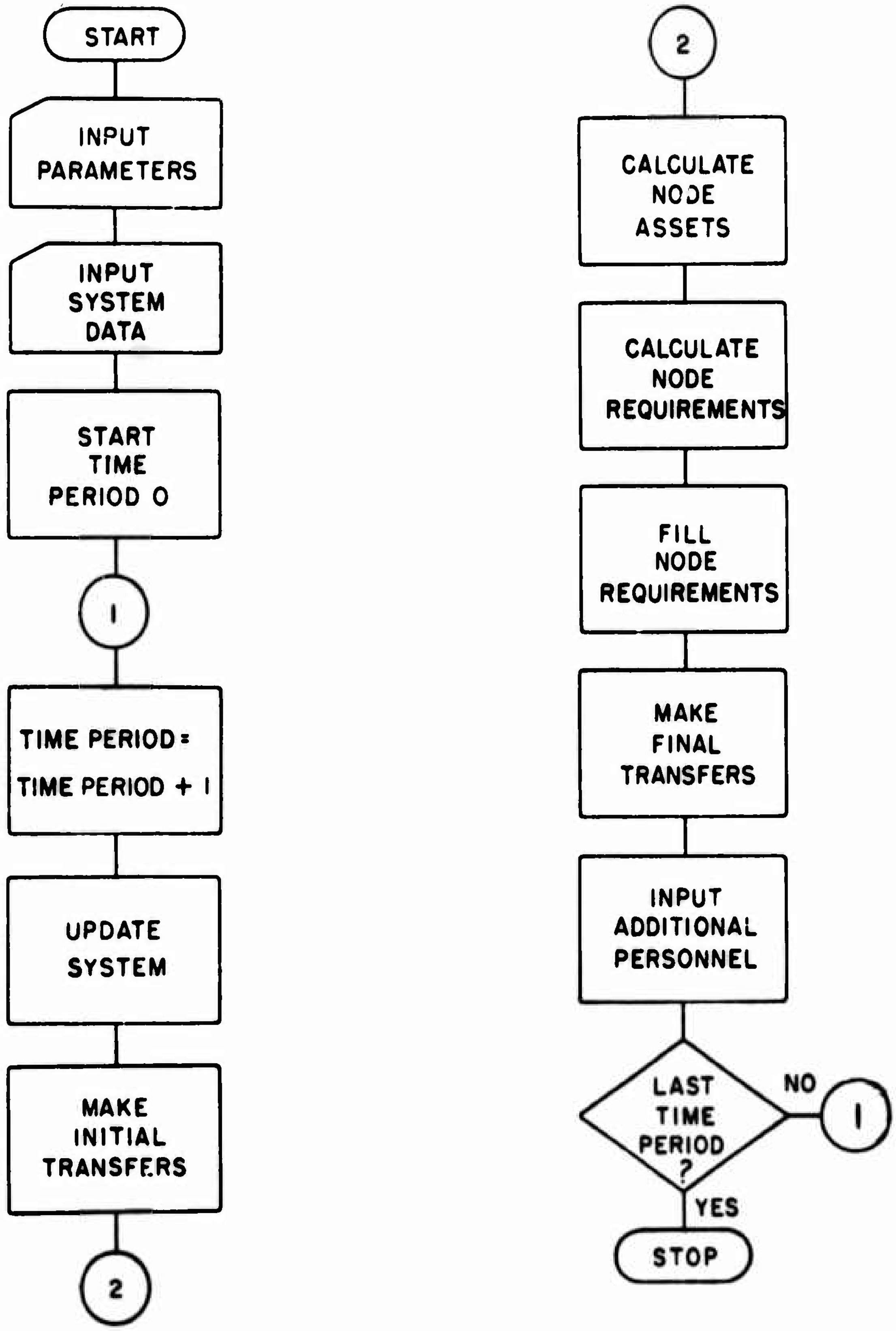


Figure 8. General matrix manipulator (GMM) logic

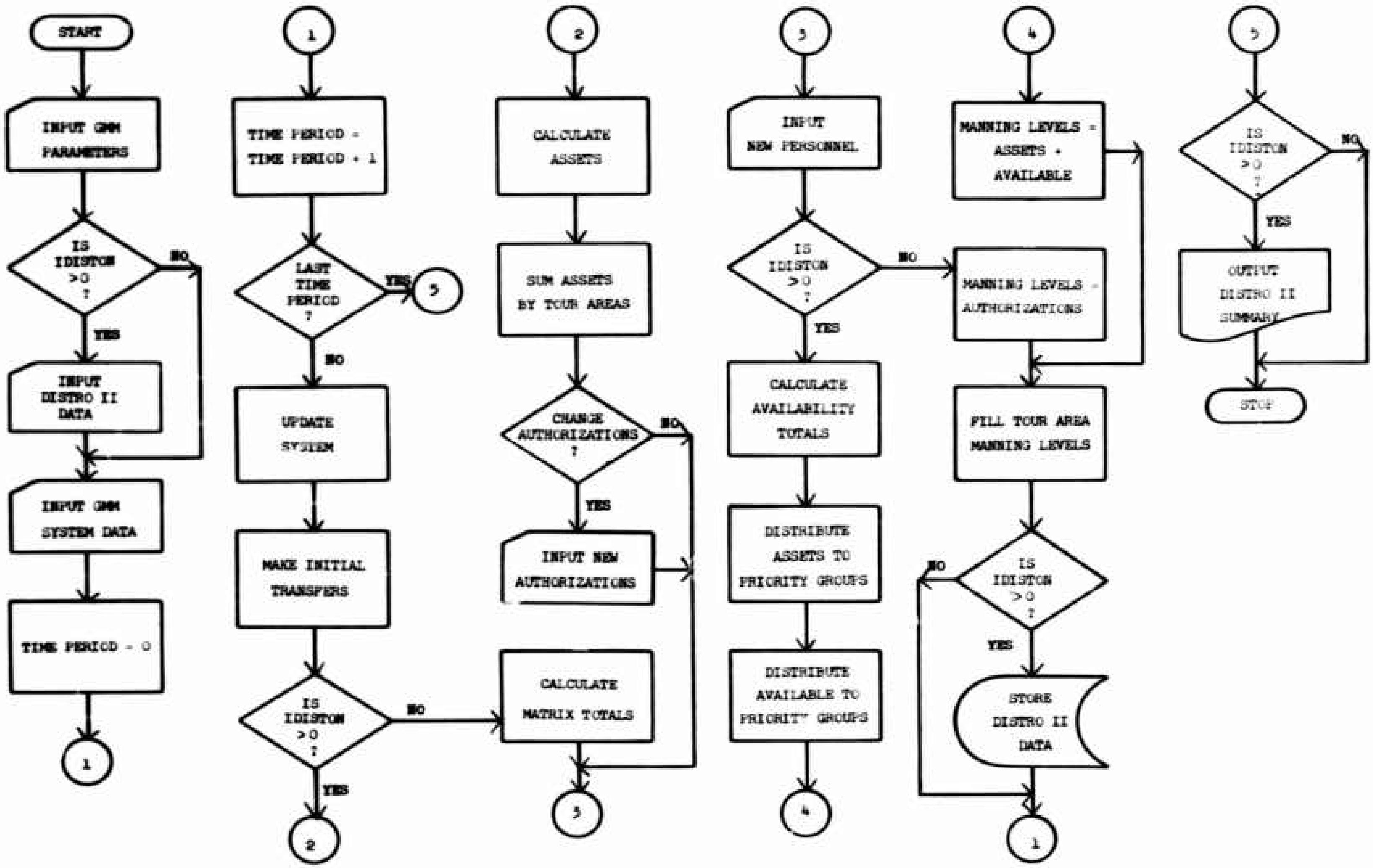


Figure 9. Interface of GMM-DISTRO II logic

4. Calculate personnel availability groups

5. Distribute assets and available personnel to priority groups

6. Convert priority group manning levels to tour area data

7. Store DISTRO II data

8. Output DISTRO II summarized data

Step 1 is executed once at the beginning of the simulation. Steps 2 through 7 are executed in sequence once during each time period of the simulation. At the end of the simulation, Step 8 is executed. These steps, monitored by the GMM main program, MAINGMM, are executed by eight separate entry points in the main DISTRO II subroutine, DISTRO2, and by an auxiliary subroutine, ALLOT (FORTRAN Listings of DISTRO2 and ALLOT are in the Appendix). The following sections describe these eight steps in detail. Included are flow charts and descriptions of the computer routines to accomplish each step and the way in which the DISTRO II routines interact with those in the GMM.

Along with other GMM parameters, the variable IDISTON is input at the beginning of each GMM simulation. If IDISTON is equal to or less than zero, the GMM proceeds without DISTRO II intervention. If IDISTON is greater than zero, however, the following eight DISTRO II steps are executed as they occur in the GMM simulation.

Step 1. *Input DISTRO II data.* The GMM relinquishes control to DISTRO2 Entry INPUTD (Figure 10) which inputs DISTRO II data. The data define the relationship of matrices representing tour areas within the GMM to priority groups (PG) within DISTRO II. Input data setup, format, and variable definitions are described in Figure 11, Table 1, and Table 2.

Entry INPUTD reads four different types of data: major parameters, availability parameters, asset parameters, and authorization and manning level parameters. Boundaries for the entire DISTRO II simulation are set by the major parameter card. The remaining input parameters operationally define these boundaries. For example, the number of availability categories, NAVCAT, input in the major parameter card, is defined in the availability parameter cards by the variables PERNOS, PERNST, and PERIAV. These variables are percentages of personnel in each matrix who are available for the three different types of assignment—NOS, NST, and IAV. Asset parameters identify GMM matrices by distribution areas for use in calculating assets. Authorizations are input for priority groups within each distribution area. For example, if there are three distribution areas (DA1, DA2, and DA3) representing short tour, long tour, and CONUS respectively, and if there are five priority groups, then there will be 15 authorizations—one for short tour priority group 1, one for short tour priority group 2, etc. Authorization and manning level parameters also include fill rates, which indicate the relative importance of filling each of the five priority groups across all distribution areas. In order to represent only one priority group within a given distribution or tour area, the user would input zero authorizations for the other four priority groups within the area. The remaining seven steps are totally dependent upon the setup of DISTRO II parameters. These parameters must be accurately estimated in order to meaningfully represent distribution capabilities of the system.

Following the input of DISTRO II data, GMM regains control to input the remaining GMM system data and to begin the simulation. After updating the system and making initial personnel transfers, the GMM teams up with DISTRO2 Entry ASSET to take an inventory of personnel assets.

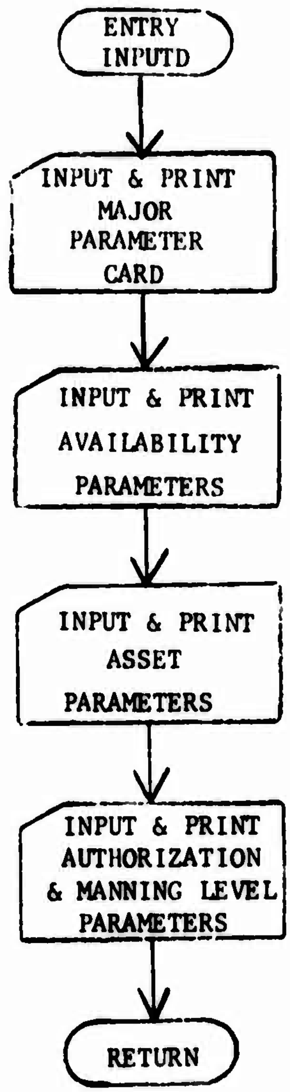


Figure 10. Entry INPUTD inputs DISTRO II data

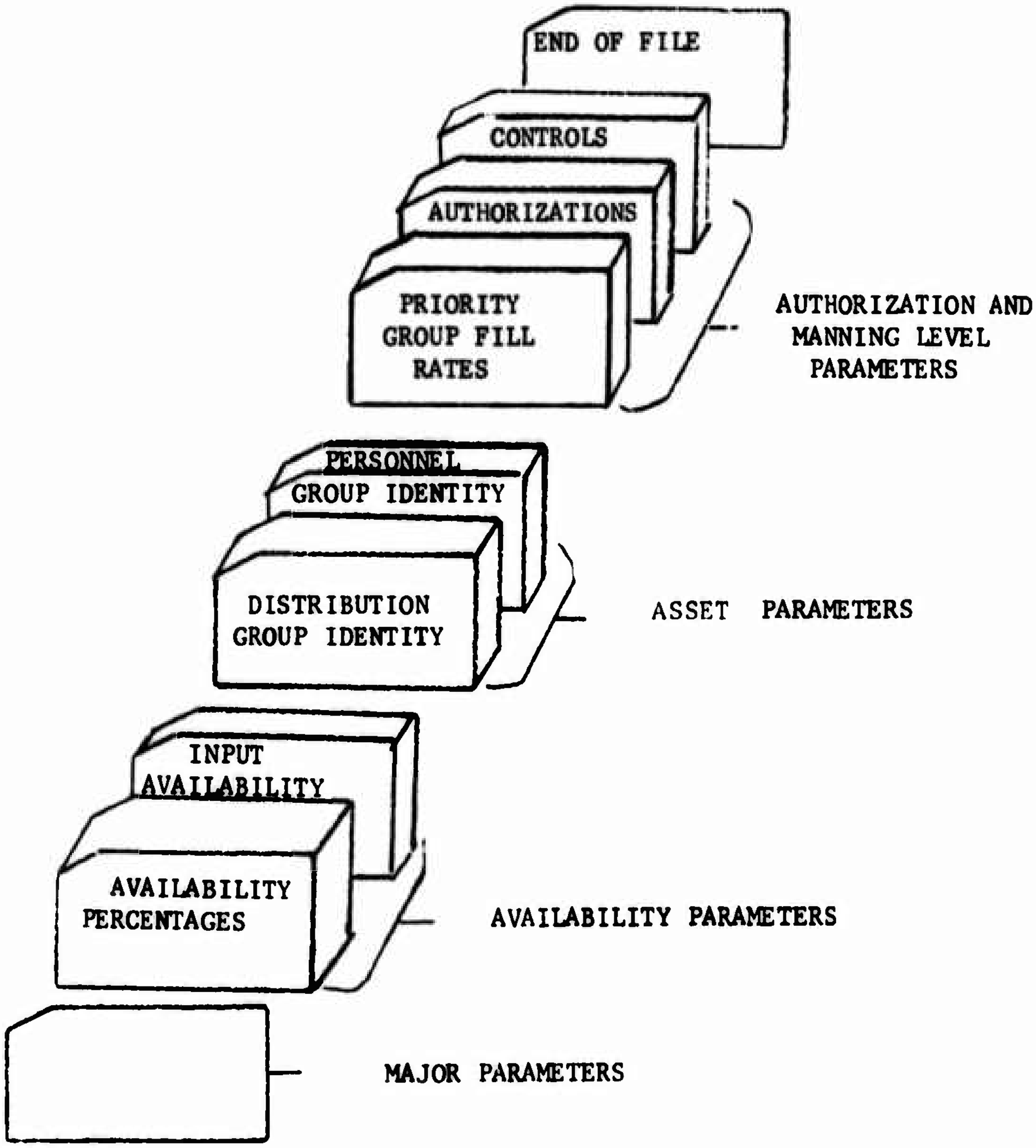


Figure 11. Data setup for DISTRO-II

Table 1

INPUT FORMAT FOR DISTRO II

Card Description	No. of Cards	Variable Name	Columns	Format
Major Parameter Card	1	NODISGR	1-10	I10
		NPERCAT	11-20	I10
		NOPRGRP	21-30	I10
		NMATRIX	31-40	I10
		NAVCAT	51-60	I10
Availability Parameter Cards	(NMATRIX* NAVCAT+8- NAVCAT)/8	PERNOS(I)	1-10	F10.3
		PERNST(I)	11-20	F10.3
		PERIAV(I) (I =1,NMATRIX)	21-30	F10.3
	CIOS/8	IOSDGR(I) (I = I,CIOS)	1-10	I10
Asset Parameter Cards	NMATRIX/8	MATWDGR(I) (I = 1,NMATRIX)	1-10	I10
	NMATRIX/8	MATWPERC(I) (I = 1,NMATRIX)	1-10	I10
Authorization and Manning Level Parameter Cards	(NOPRGRP* NODISGR)/8	R(I) (I = 1,NOPRGRP*NODISGR)	1-10	F10.3
	(NODISGR* NPERCAT* NOPRGRP)/8	AUTH(I) (I=1,NODISGR*NPERCAT*NOPRGRP)	1-10	I10
	LAST/8	NEWAUTH(I) (I = FIRST,LAST)	1-10	I10

Table 2

VARIABLES INPUT BY USER TO DISTRO II

Variable	Definition
Major Parameters	
NODISGR	Number of distribution groups or tour areas
NPERCAT	Number of personnel categories within each tour area
NOPRGRP	Number of priority groups within each tour area
NMATRIX	Number of matrices with the GMM
NAVCAT	Number of availability categories
Availability Parameters	
PERNOS(I)	Percent of personnel completing matrix I who are eligible for CONUS only (not overseas). (Distribution Group 3)
PERNST(I)	Percent of personnel completing matrix I who are eligible for CONUS and LT (not short tour). (Distribution Groups 2-3)
PERIAV(I)	Percent of personnel completing matrix I who are eligible for CONUS, LT, and ST. (Distribution Groups 1, 2 and 3)
IOSDGR(I)	Distribution group or tour area for Ith input category
Asset Parameters	
MATWDGR(I)	Distribution group of tour area for Ith matrix
MATWPERC(I)	Personnel category for Ith matrix
Authorization and Manning Level Parameters	
R(I)	Fill rate for Ith distribution priority group
AUTH(I)	Authorization for Ith distribution priority group
NEWAUTH(I)	Vector control for inputting new authorizations for month I. If in month I the NEWAUTH(I) equals 1, new authorizations are read in. If the NEWAUTH(I) equals zero, the authorizations previously read in are used.

Step 2. ***Calculate personnel assets.*** **At any point in time, each matrix can be represented as a combination of transients, current assets, and reassignables (Figure 12).**

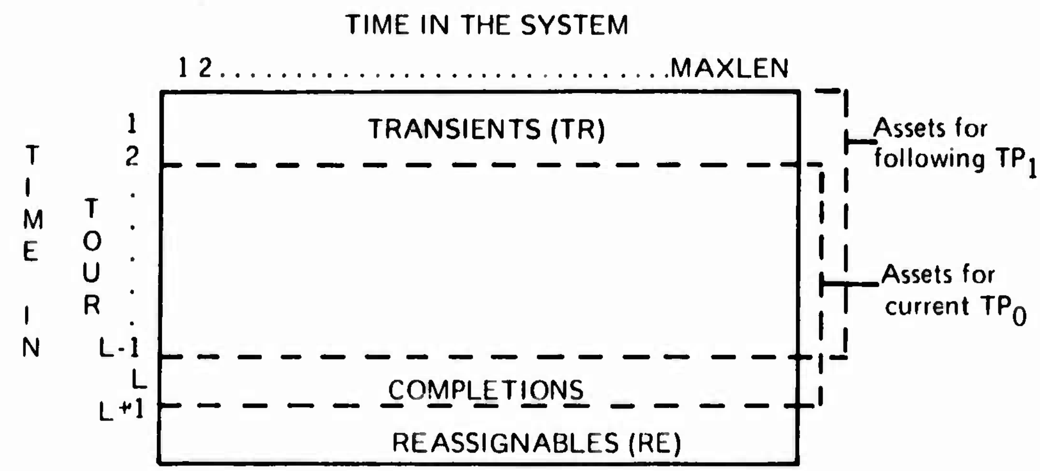


Figure 12. Types of personnel within matrix

GMM subroutine SUMMARY calculates matrix assets for the period (TP_1) following the one currently being simulated (TP_0). Each matrix is summed from row 1 in the tour through row L-1 in the tour and columns 1 through MAXLEN in the system. Matrix assets (AS) for TP_1 are equal to the sum of the transients and assets for TP_0, excluding those in their final month in the tour (completions).

$$AS_{TP_1} = TRANSIENTS_{TP_0} + ASSETS_{TP_0} \quad COMPLETIONS_{TP_0}$$

This projection of assets for the following TP_1 assumes that transients in the current TP_0 will become assets and that personnel in their last month in the tour (completions) will become eligible for reassignment in the following TP_1. After assets have been determined for each matrix, Entry ASSET (Figure 13) totals the assets for all matrices within each of the three distribution areas (DA1, DA2, DA3).

$$AS_{DA1} = \text{Assets for DA1}; \; AS_{DA2} = \text{Assets for DA2}; \; AS_{DA3} = \text{Assets for DA3}$$

The objective of the remaining steps is to input men into the proper DA and PG one TP in advance. After updating at the end of the current TP_0, the currect number of men should be serving in the areas where they are needed.

Step 3. *Summarize authorizations.* The Ith element of the NEWAUTH vector is checked during each time period. If the element equals zero, the last authorizations input to the model are employed. If the element is positive, DISTRO2 reads new authorizations for each PG and DA. Entry AUTHOR (Figure 14) then sums these authorizations for each DA.

$$AUTH_{DAJ,PGI} = \text{Authorization for Ith PG within Jth DA}$$

The GMM regains control to input new personnel into the system after which control returns to DISTRO2 for calculation of personnel available for reassignment.

Step 4. *Calculate personnel availability groups.* In each matrix during the TP_0, all personnel available for reassignment can be broken into three categories: (1) NOS, (2) NST, and (3) IAV. Entry AVAIL (Figure 15) multiplies the number of reassignable personnel (RE) from each of the matrices in the GMM by its availability parameters (PERNOS, PERNST, and PERIAV) and determines how many people are categorized as NOS, NST, and IAV. To these totals it adds new system input to the appropriate eligibility category.

$$NOS = \Sigma \; (RE_I \; * \; PERNOS_I) + INPUT_{NOS}$$

$$NST = \Sigma \; (RE_I \; * \; PERNST_I) + INPUT_{NST}$$

$$IAV = \Sigma \; (RE_I \; * \; PERIAV_I) + INPUT_{IAV}$$

Steps 1 through 4 are not an integral part of the distribution process. They convert GMM data into a form compatible with DISTRO2 and then calculate summary data. This data preparation is necessary prior to the actual distribution process, which is accomplished by Step 5.

Step 5. *Distribute assets and available personnel to priority groups.* The distribution process consists of a series of separate distributions of different groups of personnel. The entire process is directed by Entry DISTR (Figure 16), the brain of the DISTRO II model. According to the instructions given by Entry DISTR, Subroutine ALLOT accomplishes the actual distribution of specific groups of personnel. Following each separate distribution by ALLOT, control returns to Entry DISTR for additional instructions.

Initially, DISTR directs ALLOT to distribute current assets in each DA to PG's within that DA. These assets will have an influence on the number of additional personnel assigned to each DA-PG. After the current assets have been distributed within their own DA's, DISTR directs ALLOT to distribute all personnel available for reassignment to PG's across appropriate DA's considering current assets in the DA-PG, authorizations for the DA-PG, and the number of personnel available for that DA-PG. First, the most restricted personnel, NOS, are distributed to DA3. Then NST personnel are distributed among PG's within DA2 and DA3. Finally, the most unrestricted personnel, IAV, are distributed to all PG's within all DA's. This sequence of distributions is described below in detail, including the actual steps which Subroutine ALLOT takes to accomplish each of the distributions.

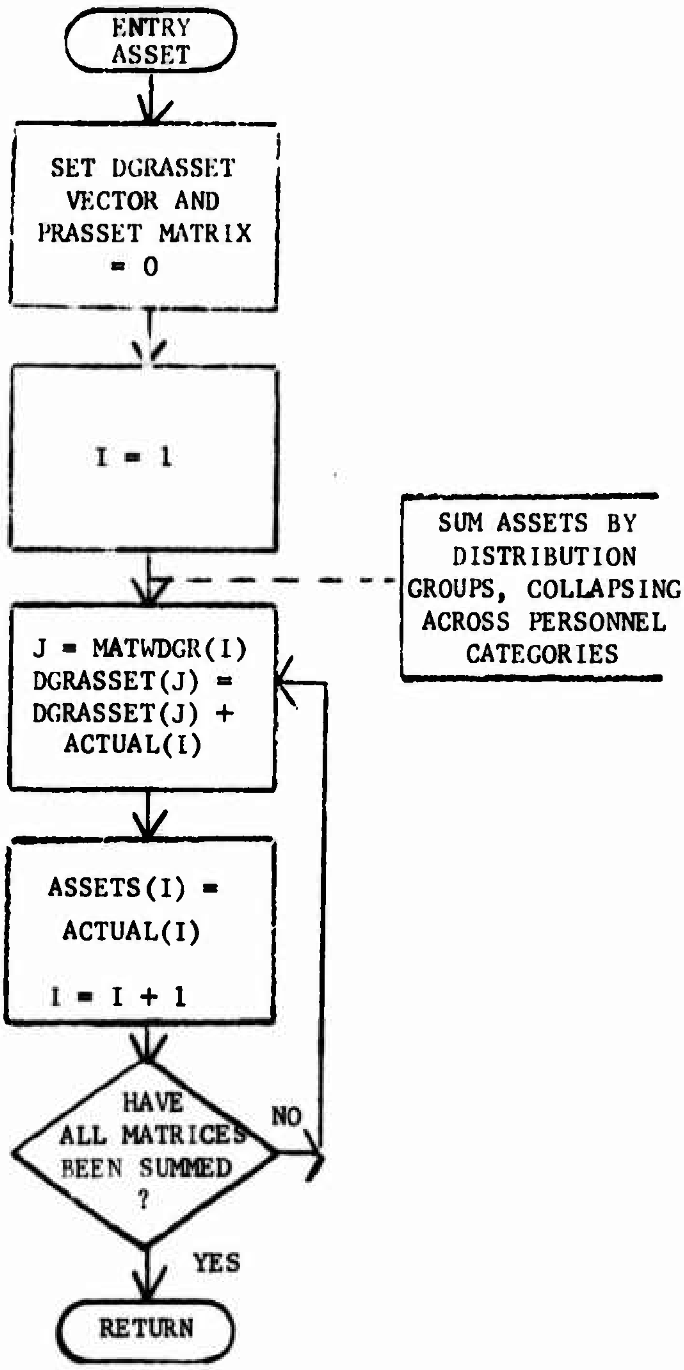
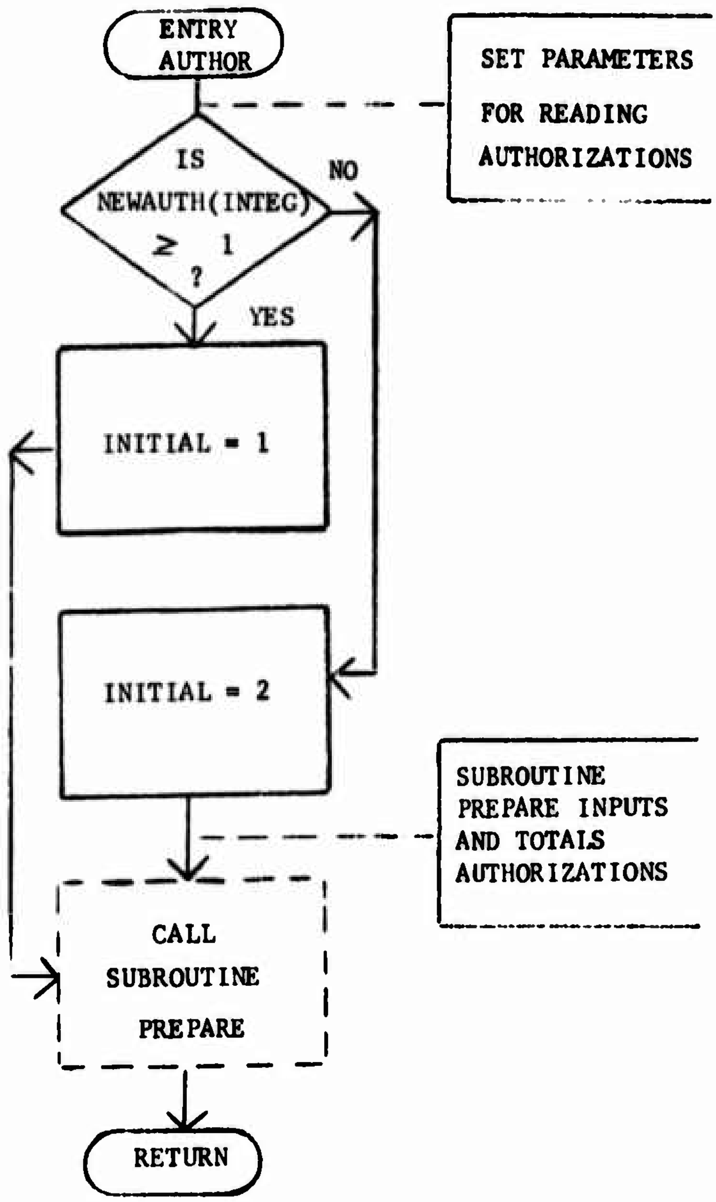


Figure 13. Entry ASSET sums assets



14. Entry AUTHOR sums authorizations

To transfer control to Subroutine ALLOT, Entry DISTR uses the following call statement:

Call ALLOT(NEWIP, IDIS, NOPRGRP, NODIS, IOVER)

The values of the input elements—NEWIP, IDIS, NOPRGRP, and NODIS—, calculated in DISTR, determine the following conditions for the distribution process:

NEWIP—amount of new input available for distribution

IDIS—first DA to which NEWIP will be distributed

NOPRGRP—number of PG's within each DA

NODIS—number of DA's across which NEWIP will be distributed. The element, IOVER, is calculated in ALLOT and is returned to DISTR as the number of available personnel over and above PG authorizations. This overage will be distributed to DA3 at the end of the distribution process.

Initially DISTR directs ALLOT to distribute current assets within DA's to PG's.

Call ALLOT(AS_{DAj}, J, NOPRGRP, 1,0)

Subroutine ALLOT gains control and proceeds with the following steps to accomplish the distribution (Figure 17).

a. It obtains asset totals for each PG across all DA's.

$$SUMASS(I) = \sum_{j=IDIS}^{IDIS+NODIS-1} (AS_{DAj,PGi})$$

If ALLOT is distributing current assets, the assets ($AS_{DAj,PGi}$) are equal to zero prior to the distribution. Therefore, SUMASS(I) equals zero.

b. It obtains authorization totals for each priority group across all DA's concerned.

$$SUMAUTH(I) = \sum_{j=IDIS}^{NODIS+IDIS-1} (AUTH_{DAj,PGi})$$

c. It obtains priority group weighted shortfalls across all DA's.

PRNEED(I) = (SUMAUTH(I) - SUMASS(I)) * R(I)

Also, it obtains the total weighted PG shortfall.

$$SUMNEED = \sum_{I=1}^{NOPRGRP} (PRNEED(I))$$

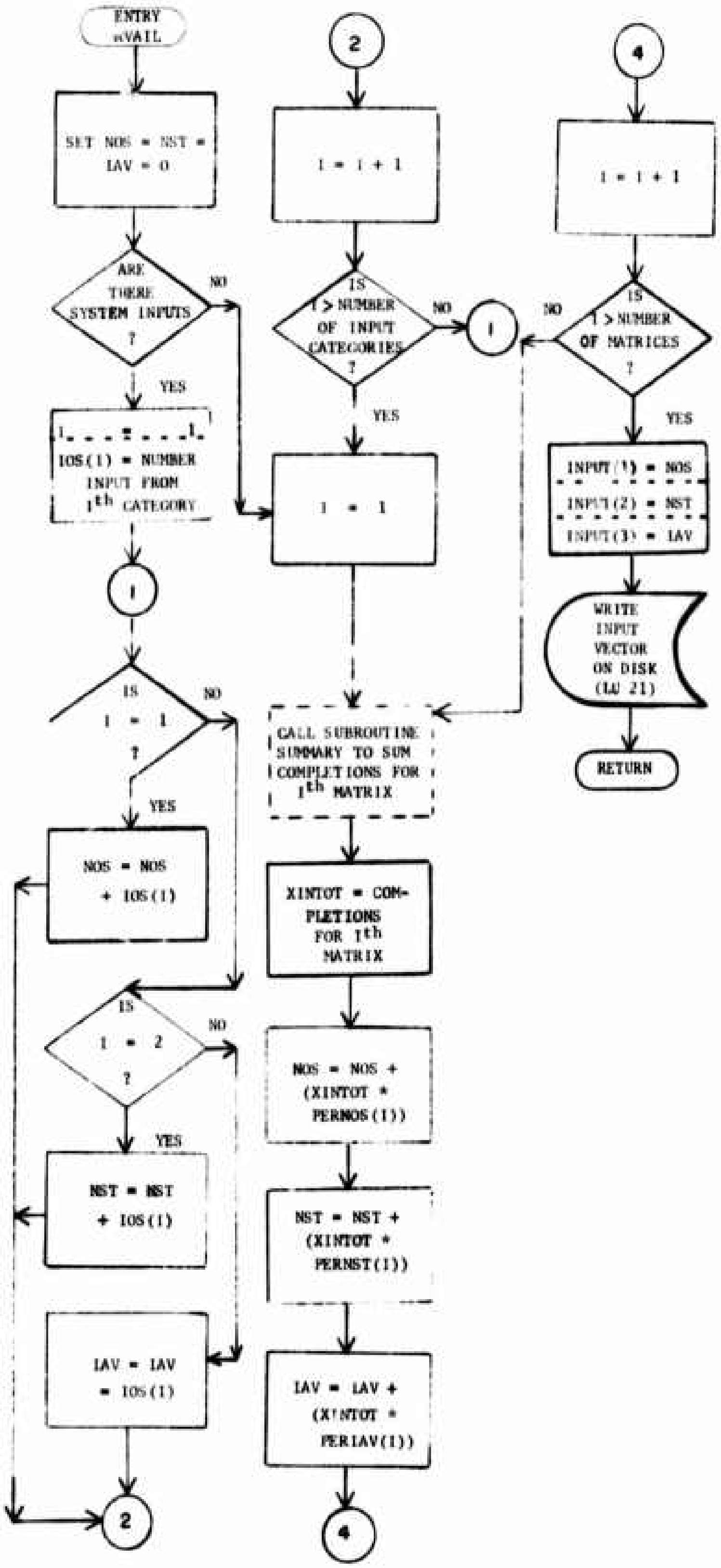


Figure 15. Entry AVAIL summarizes available personnel

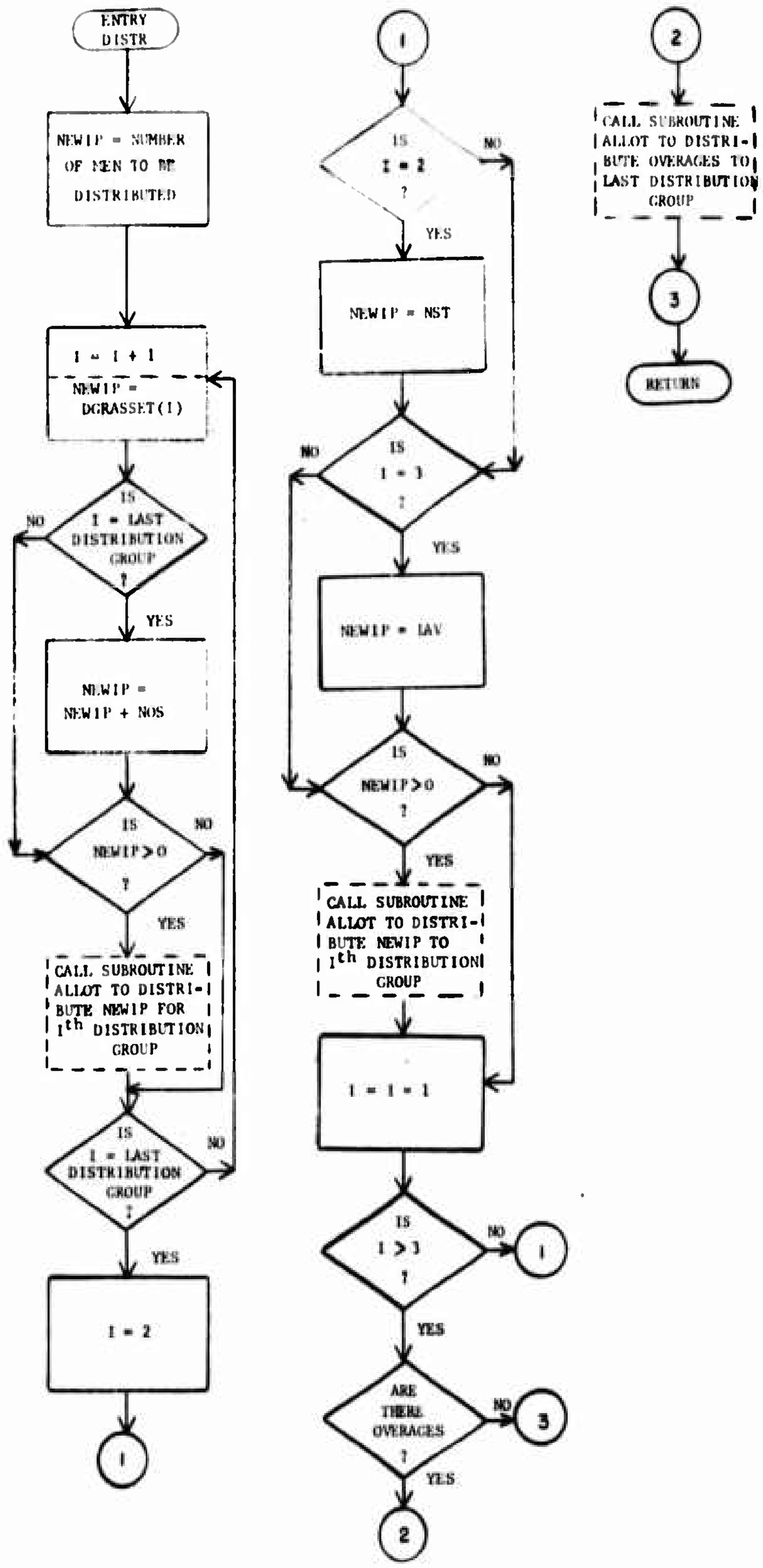


Figure 16. Entry DISTR controls personnel distribution

d. Using the information obtained in steps a through c, it determines how many personnel should be input to PGs within DAs.

$$NEWIN_{DAj,PGi} = (NEWIP/SUMNEED) * PRNEED(I) * (AUTH_{DAj,PGi}/SUMAUTH(I))$$

e. It adds the new input to the respective DA-PG assets.

$$AS_{DAj,PGi} = AS_{DAj,PGi} + NEWIN_{DAj,PGi}$$

Authorizations for DA-PG serve as ceilings for DA-PG except when current assets are being distributed within their own distribution areas. When distributing NOS, IAV, and NST personnel, DA2 and DA1 should be held to their authorization levels. All excess personnel (those over the authorizations) should be accumulated in the variable IOVER.

f. After current assets have been distributed within their DA's, DISTR directs ALLOT to distribute NOS men to DA3.

Call ALLOT (NOS, 3, 5, 1, 0)

Employing these parameters, ALLOT repeats steps a through e.

g. ALLOT is directed to distribute NST men to DA2 and DA3.

Call ALLOT (NST, 2, 5, 2, 0)

(Repeat steps a through e)

If IOVER is greater than zero, IOVER is distributed to DA3.

h. IAV personnel are distributed to DA1, DA2, and DA3.

Call ALLOT (IAV, 1, 5, 3, 0)

(Repeat steps a through e)

i. If there are men above the authorization levels in DA2 and DA1, (IOVER), distribute IOVER to DA3.

Call ALLOT (IOVER, 3, 5, 1, 0)

After all personnel have been distributed, the matrix $AS_{DAj,\ PGi}$ represents projected manning levels for the Ith PG within the Jth DA for the following time period (TP_1).

Step 6. *Convert priority group manning levels to tour area data.* Entry GMMANLEV (Figure 18) totals PG manning levels within each DA.

$$MANLEV_{DAJ} = \sum_{I=1}^{NOPRGRP} AS_{DAJ,PGI}$$

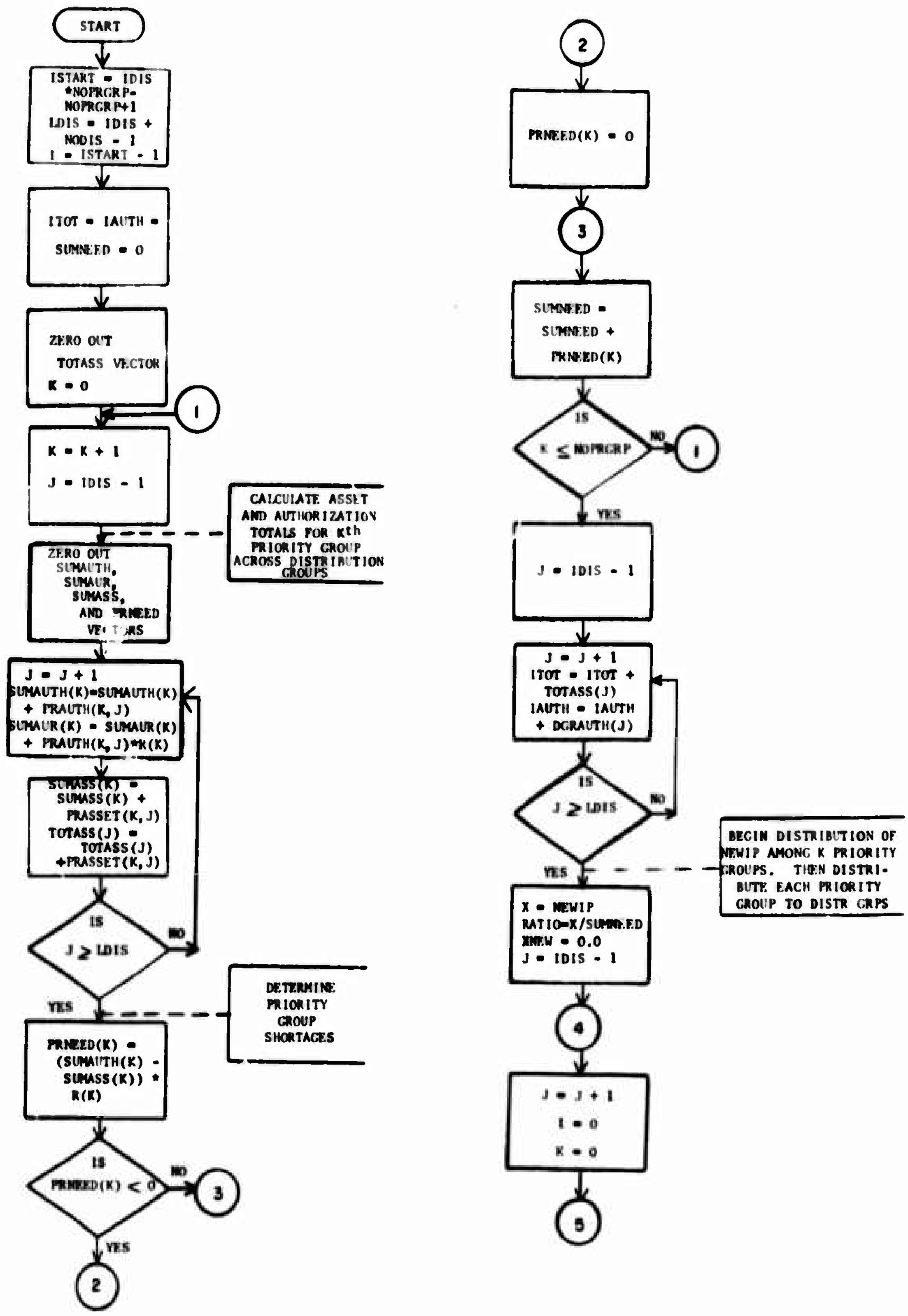


Figure 17. Subroutine ALLOT distributes personnel

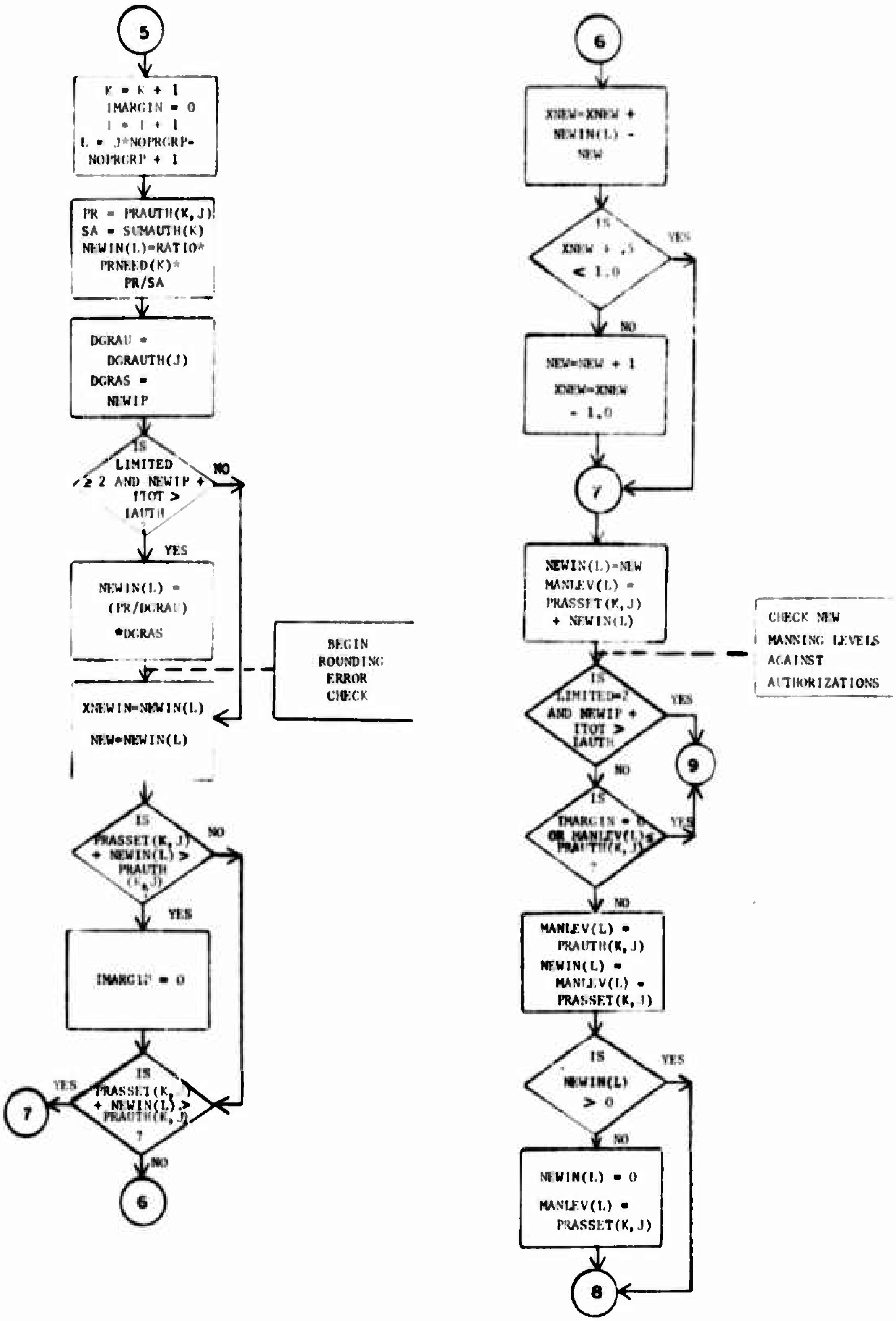


Figure 17 continued

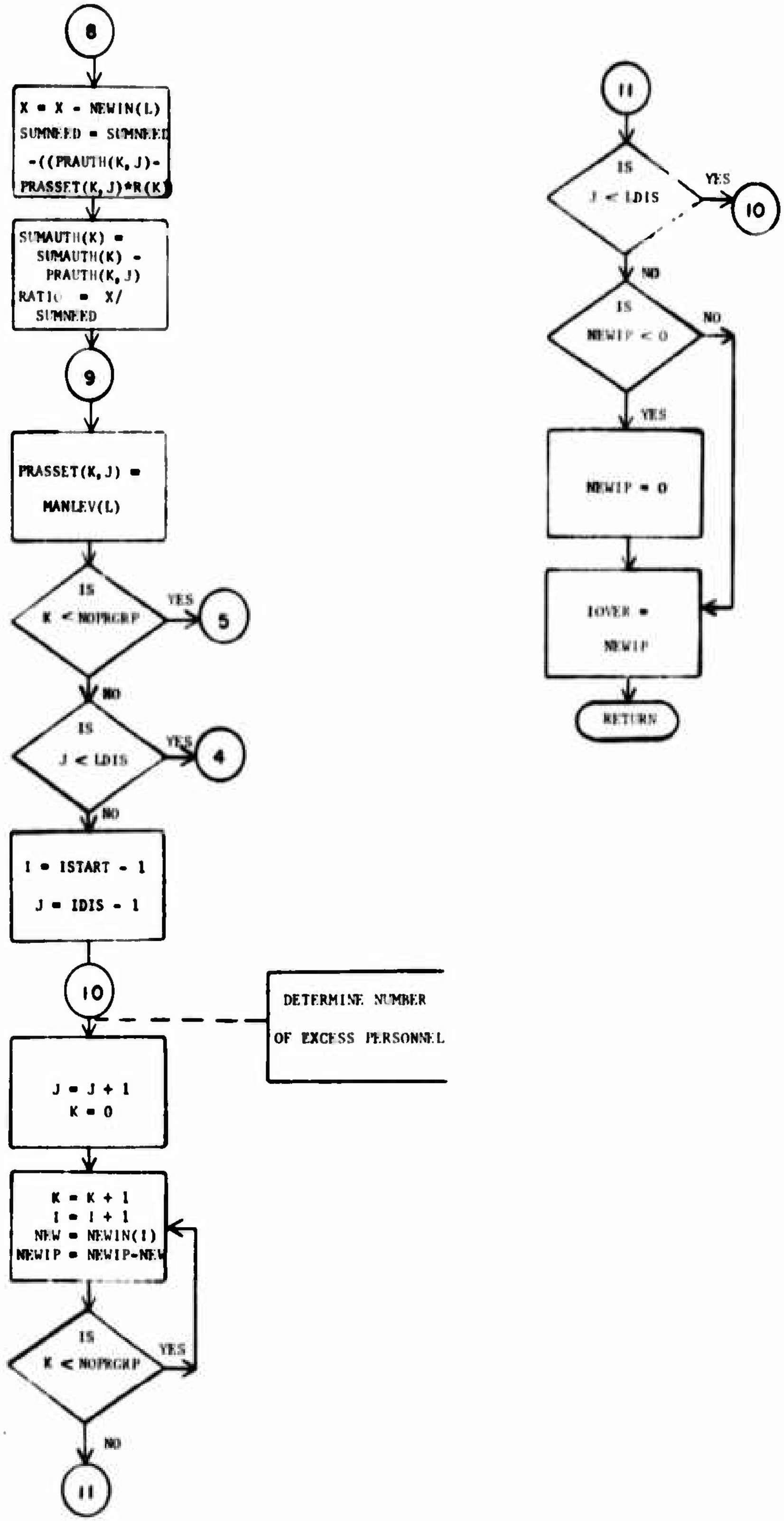


Figure 17 continued

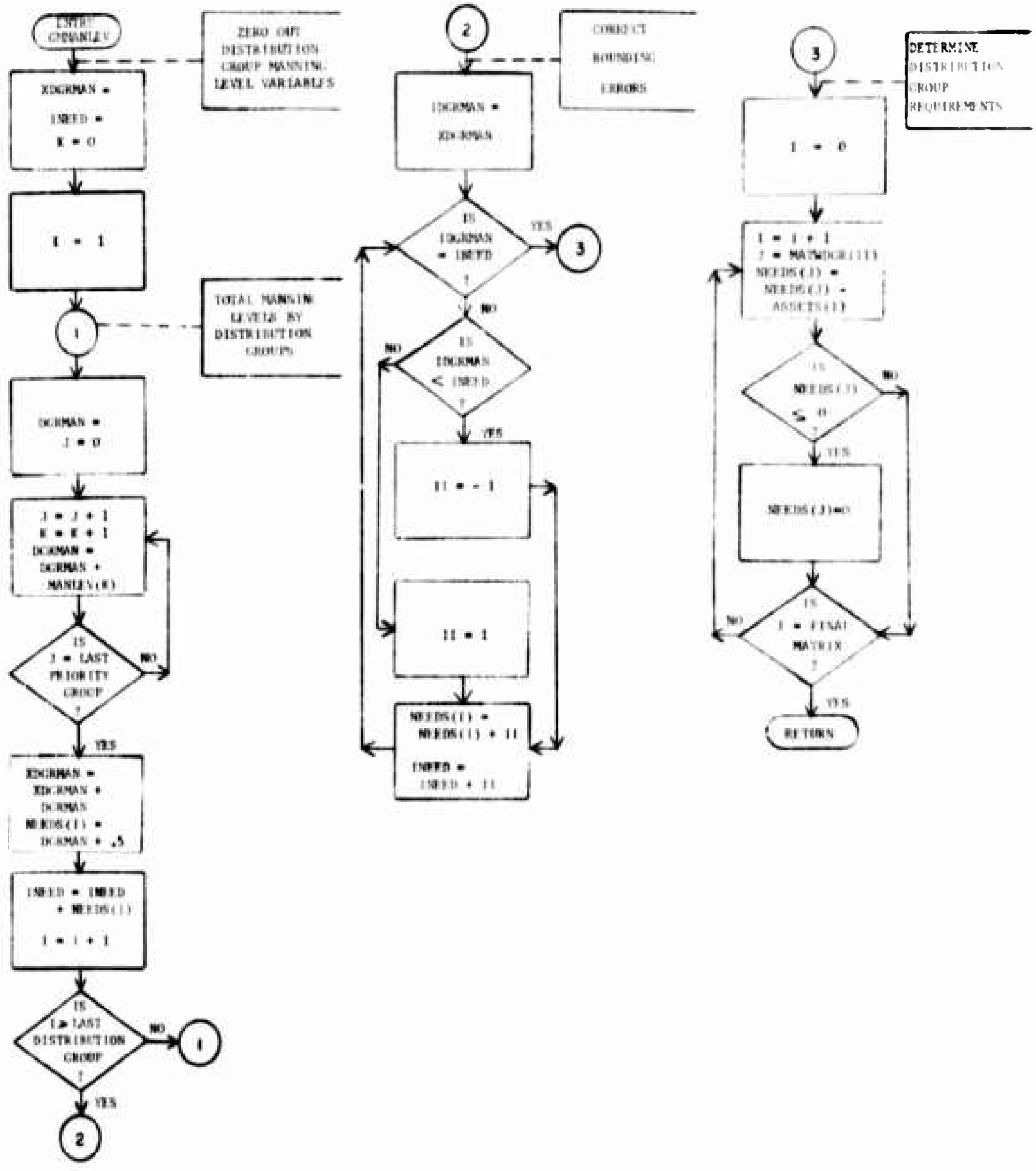


Figure 18. Entry GMMANLEV determines tour requirements

These DA manning levels will serve as tour area manning levels in the GMM. From the DA manning levels, Entry GMMANLEV subtracts the actual number of current assets in the tour area to obtain the number of men who will be input to the tour areas by the GMM.

$$NEEDS_{DAJ} = MANLEV_{DAJ} - ASSETS_{DAJ}$$

The GMM then regains control and fills these tour area needs according to the priority of fill rules.

Step 7. *Store DISTRO II data.* At the end of the time period, Entry DATASTOR (Figure 19) gains control, calculates summary data, and stores the data on a disk pack for use at the end of the simulation. Entry DATASTOR totals assets for the time period by summing rows 2 through L in the tour and columns 1 through MAXLEN in the system in each matrix. It totals transients in row 1 and columns 1 through MAXLEN for each matrix also. These totals are then arranged within tour areas and stored on the disk.

Personnel distributed by DISTR are projected assets and transients for PGs within DAs. These projections determine manning levels in GMMANLEV which are in turn filled according to the priority of fill rules in the GMM. The data stored in DATASTOR summarize the actual number of assets and transients for each matrix in the GMM after personnel have been moved. These actual assets and transients are the data which are of interest to management.

Step 8. *Output DISTRO II summarized data.* Entry OUTPUTD (Figure 20) initially reads the data stored by DATASTOR. It then transforms the matrix data into DA data and redistributes it to the PG's across DA's. Transients from the current time period TP_0 being output are distributed in relation to assets for the following TP_1.

OUTPUTD prints the following information for each time period which has been simulated.

TIME BLOCK N

DISTRIBUTION GROUP J

Priority Group	Number Authorized	Manning Level	Percent Fill	Shortfall	Transients

This output describes the time period which is being summarized, the distribution area or tour area, and the priority group within the tour area. Each priority group is further described by its authorization, actual manning level, percent of authorizations filled, its shortfall, and the number of transients who will become assets in the next time period. This output presents management with a detailed picture of where its personnel are located. The DISTRO II output locates men in priority groups within distribution or tour areas. By looking also at the GMM output, management can see the specific types of personnel who are serving in any one distribution or tour area.

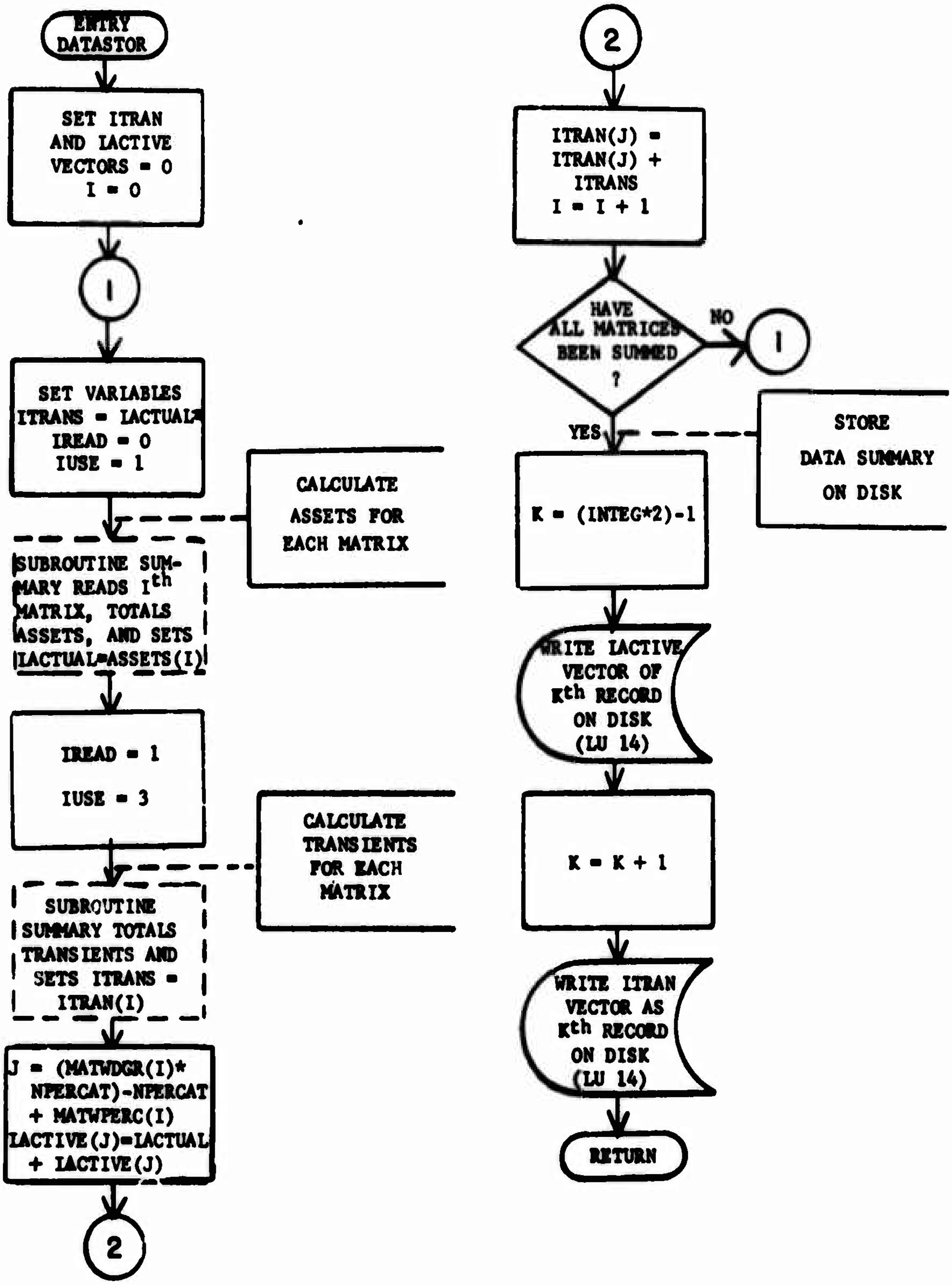


Figure 19. Entry DATASTOR stores DISTRO-II data

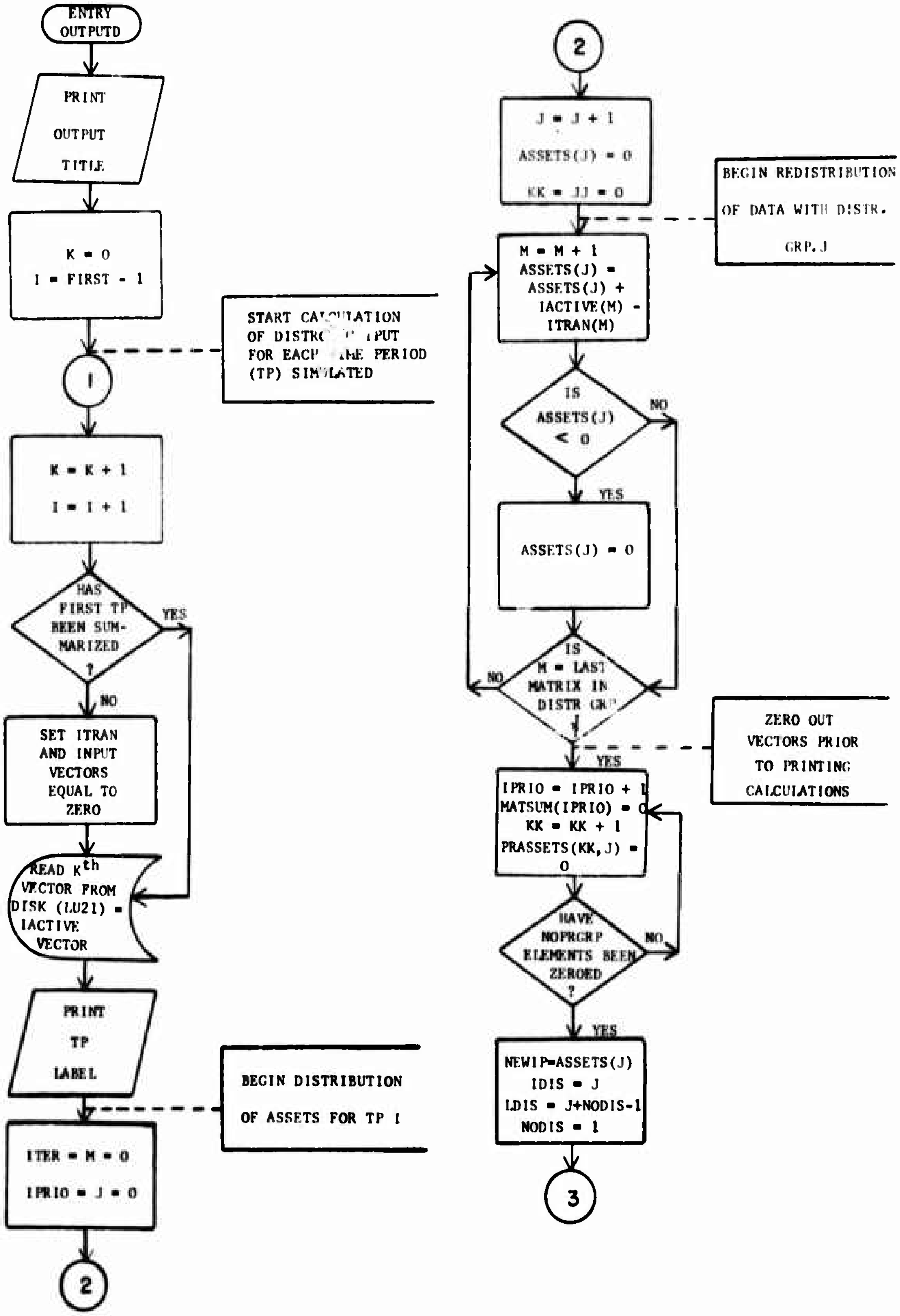


Figure 20. Entry OUTPUTD outputs DISTRO2 summary

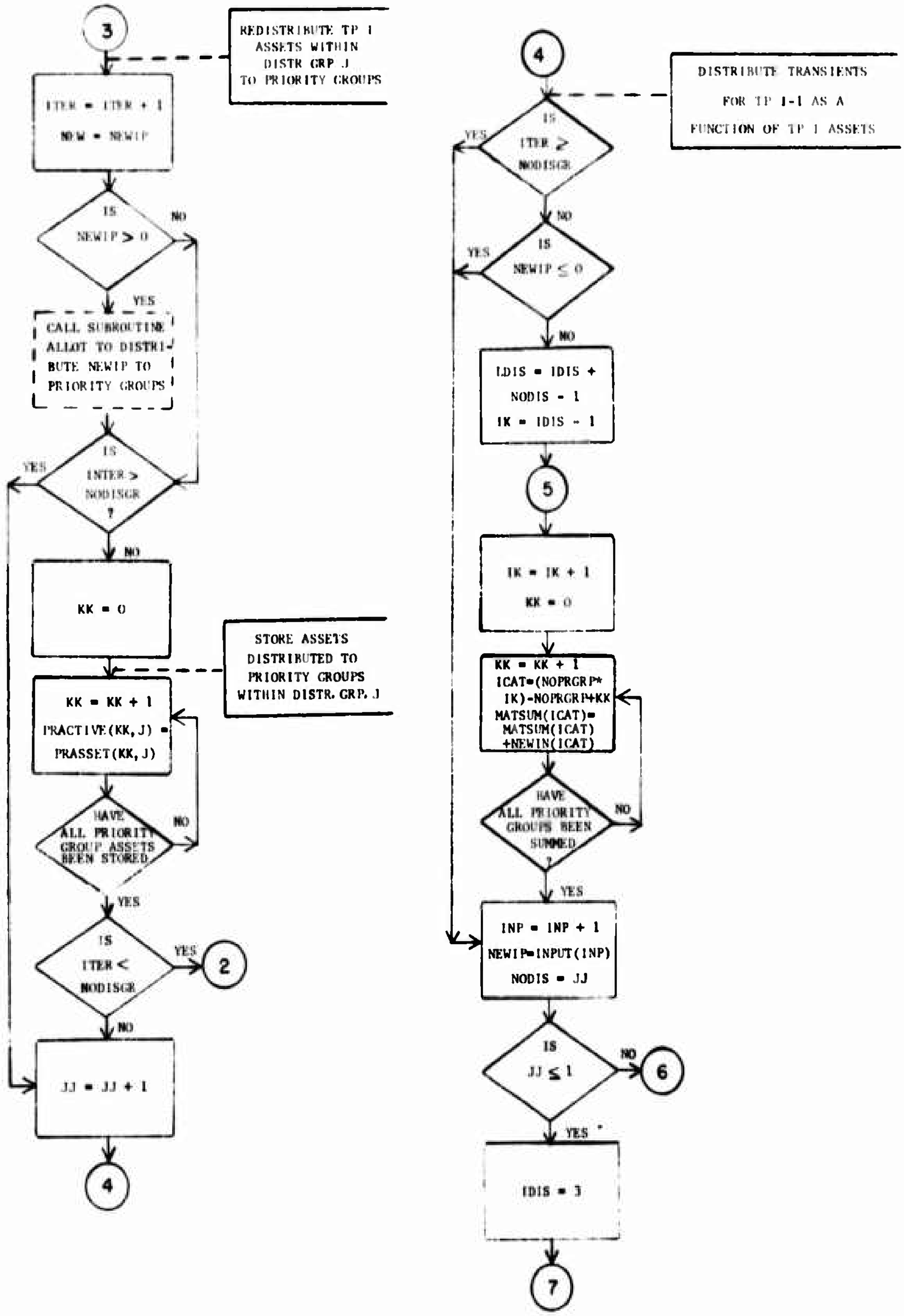


Figure 20 continued

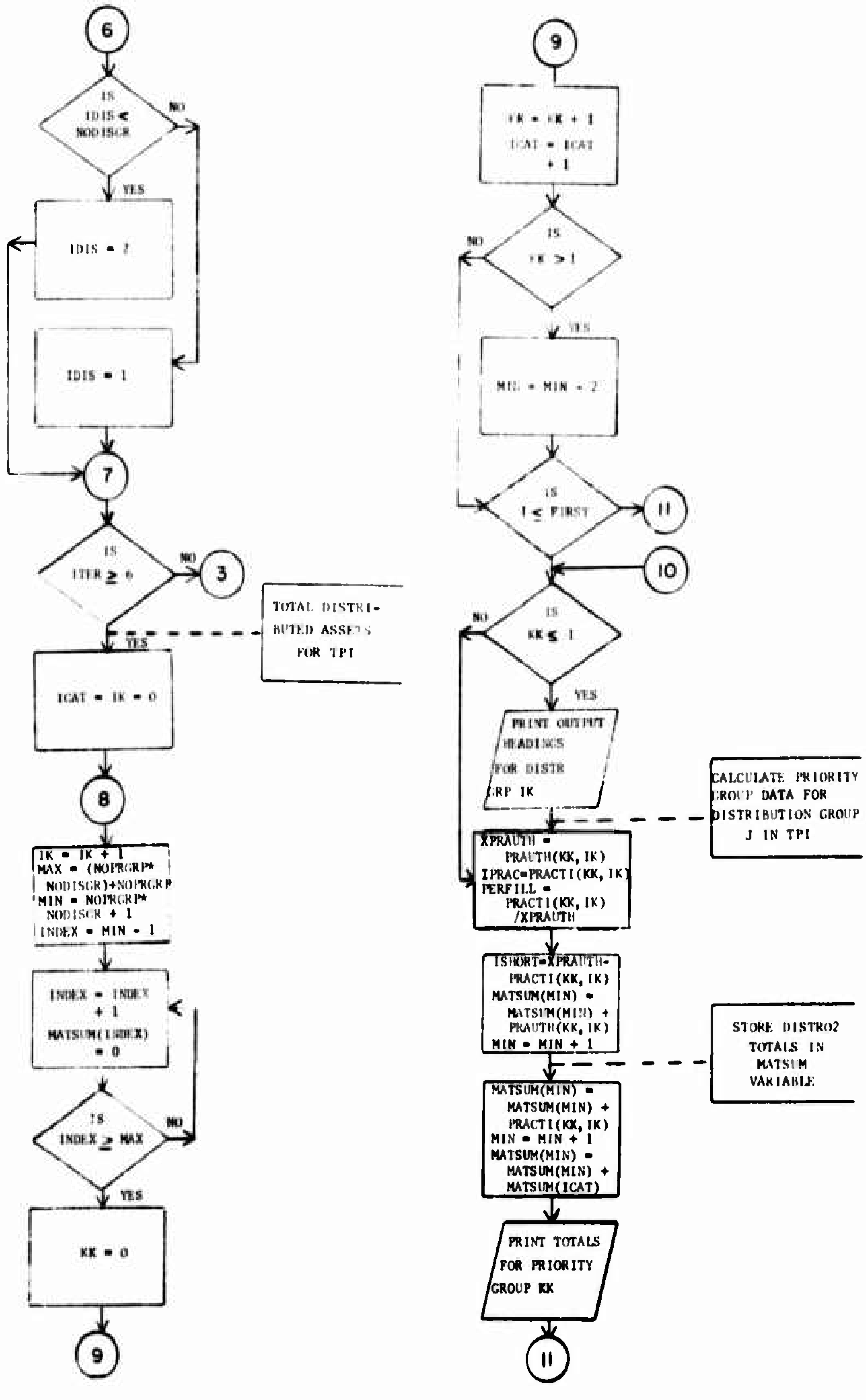


Figure 20 continued

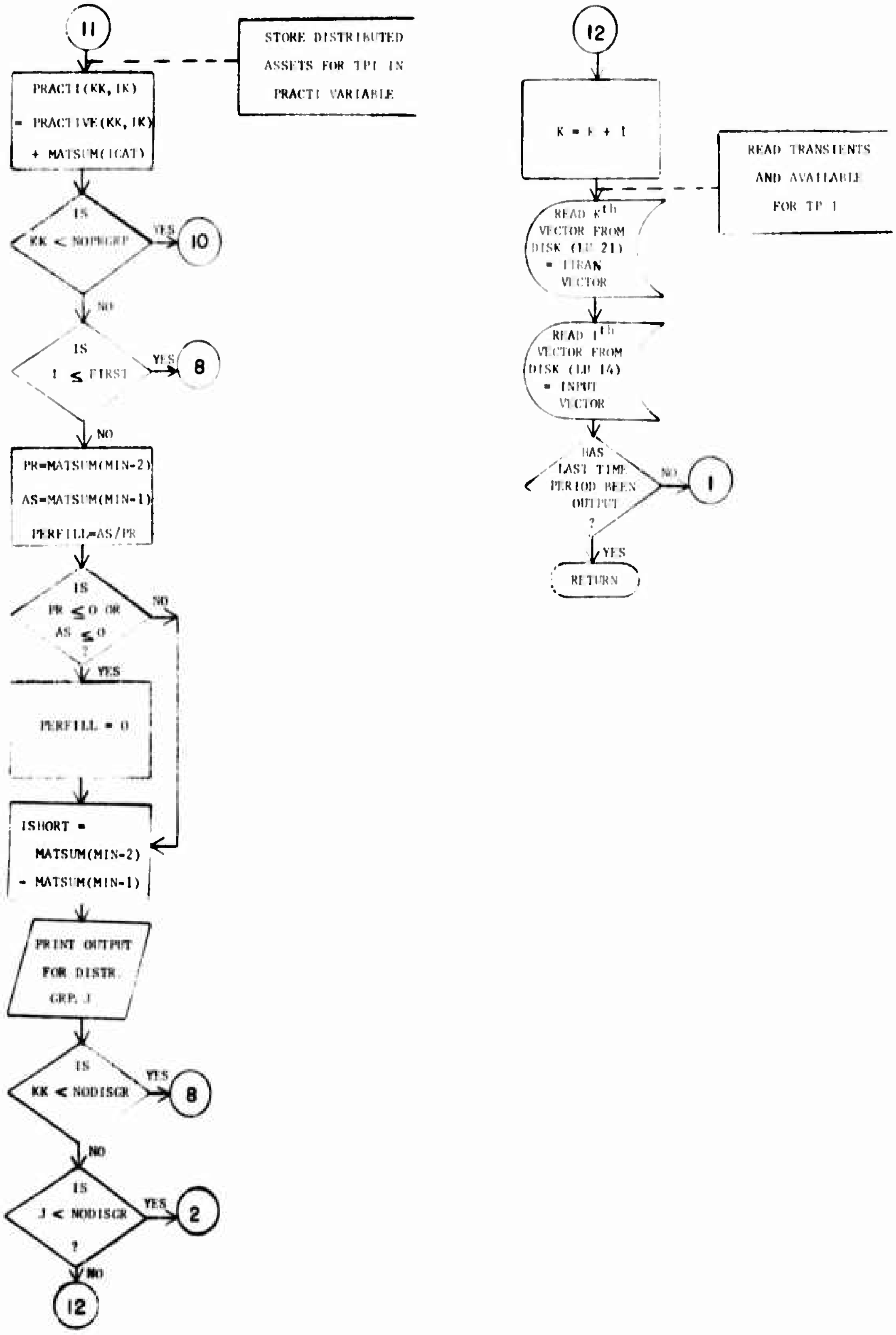


Figure 20 continued

APPENDIX

FORTRAN LISTINGS OF DISTRO2 SUBROUTINES

```
      SUBROUTINE DISTR02
C
C     NOVEMBER 1969-PROGRAMMER WITT
C
C     SUBROUTINE DISTR02 DETERMINES MANNING LEVELS FOR DISTRIBUTION AREAS
C         BASED ON WORLD WIDE AVAILABILITY OF PERSONNEL.
C         CALCULATES TOTAL ASSETS CURRENTLY SERVING IN AN AREA.
C         CALCULATES TOTAL AVAILABLE FOR REASSIGNMENT TO SPECIFIC DISTRIBUTION
C         AREAS.
C
      COMMON        IP        ,INE(48)   ,IFND      ,JK        ,SYST(48,48)
      COMMON        ITRTIME   ,NOTR(10)  ,LENGTH(100)          ,OUT(100)
      COMMON        TRINT(100),TRINS(100)           ,TROUTT(100)
      COMMON        TROUTS(100)          ,FSTROWO(100)         ,LSTROWO(100)
      COMMON        FSTCOLO(100)         ,LSTCOLO(100)         ,FSTROWI(100)
      COMMON        FSTCOLI(100)         ,PCTOUT(100)          ,PCTIN(100)
      COMMON        NFEDS(30),NE(30,10),NSTT(30), INOS(10,10)            10FEB 71
      COMMON        INTOUR(50),          INSUB(50),OUTTOUR(50)          6 JAN 71
      COMMON        OUTSUB(50),          AFTER(50),PER(50), PEROUT(50)  6 JAN 71
      COMMON        REP(50),  IOD(50),   IGRADE(50),        ITYPE(50)   6 JAN 71
      COMMON        IOS(10)   ,NED(30)   ,NFF(100) ,IFILL   ,MAXLEN    10FEB 71
      COMMON        NTOUR     ,NP        ,CIOS      ,SYS(48,48)
      COMMON        PDW       ,LSTRSTO(10)          ,LSTRSTT(10)
      COMMON        LSTRSTS(10)          ,ITT       ,MAXSUB    ,ACT(30)   10FEB 71
      COMMON        IDISTON   ,ISUM      ,GRPSUM(100)
      COMMON        BEGROW(100)          ,ENDROW(100)          ,BEGCOL(100)
      COMMON        ENDCOL(100)          ,MATSUM(100)          ,MATGRPS(100)
      COMMON        TYPE(100),SUB(100)   ,NUM(100)  ,ACTUAL(100)
      COMMON        NPRLEV    ,NT        ,IHOLD     ,LEN       ,LEVEL     ,M
      COMMON        NCRNODE(100)         ,MIN(100)  ,GRPINPR(100)
      COMMON        INTEG     ,NOTT      ,FIRST     ,LAST      ,IPRINT    26FEB71
C     FOLLOWING COMMON STATEMENTS USED ONLY IN ASSET,PREPARE, AND ALLOT
      COMMON        AUTH(100) ,PRAUTH(10,10)        ,ASSETS(100)
      COMMON        MATWDGR(100)         ,R(100)    ,PRASSET(10,10)
      COMMON        DGRASSET(100)        ,PERNOS(100)          ,PERNST(100)
      COMMON        PERIAV(100)          ,MATWPERC(100)
      COMMON        FILL(100) ,MANLEV(100)          ,NEWIN(100)
      COMMON        LIMITED   ,IOSDGR(100)          ,NEWAUTH(100)
      COMMON        DGRAUTH(100)         ,MANDGR(100)          ,NAVCAT
C     IACTIVE AND ITRAN OVERLAP IN COMMON WITH X59A VARIABLE IBI.
      COMMON        IACTIVE(100)         ,ITRAN(100)
      COMMON        PRACTIVE(10,10)
      INTEGER       TYPE      ,SUB       ,ACTUAL    ,ENDCOL    ,SYS
      INTEGER       CIOS      ,SYST      ,OUTSUB    ,OUTTOUR   ,AFTER
      INTEGER       ACT       ,FIRST     ,GRPSUM    ,BEGROW    ,ENDROW
      INTEGER       BEGCOL    ,TRINT     ,TRINS     ,TROUTT    ,TROUTS
      INTEGER       FSTROWO   ,FSTCOLO   ,FSTROWI   ,FSTCOLI
      INTEGER       AUTH      ,PRAUTH    ,ASSETS               ,DGRASSET
      INTEGER       FIRST     ,DGRAUTH   ,SUMAUTH   ,FILL
      REAL          MENUSED   ,MANLEV
C
C     SECTION 1
C     ENTRY INPUTD INPUTS DISTRIBUTION DATA
      ENTRY INPUTD
C
      READ 100,NODISGR,NPERCAT,NOPRGRP,NMATRIX,LIMITED,NAVCAT,IPERIOD
C     NODISGR=NUMBER OF DISTRIBUTION GROUPS.
C     NPERCAT=NUMBER OF PERSONNEL CATEGORIES.
C     NOPRGRP=NUMBER OF PRIORITY GROUPS.
C     NMATRIX=NUMBER OF MATRICES SIMULATED.
```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```
C     NAVCAT=NUMBER OF AVAILABILITY CATEGORIES.
      PRINT 200, NODISGR,NPERCAT,NOPRGRP,NMATRIX,NAVCAT
C
C     PARAMETERS TO DETERMINE AVAILABILITY
C     PERCENT OF AVAILABLE FROM ITH MATRIX WHO ARE ELIGIBLE FOR
C        CONUS ONLY = PERNOS(I).   (NOT OVERSEAS)
C        CONUS AND LT=PERNST(I).   (NOT SHORT TOUR)
C        GENERAL DISTRIBUTION = PERIAV(I).
      READ 101,(PERNOS(I),PERNST(I),PERIAV(I),I=1,NMATRIX)
      PRINT 201,(I,PERNOS(I),PERNST(I),PERIAV(I),I=1,NMATRIX)
      IF(CIOS.LE.0) GO TO 5
C     IOSDGR(I)=DISTRIBUTION GROUP FOR ITH INPUT CATEGORY.
      READ 100,(IOSDGR(I),I=1,CIOS)
      PRINT 208,(I,IOSDGR(I),I=1,CIOS)
C
C     PARAMETERS TO DETERMINE ASSETS
C     MATWDGR(I)=DISTRIBUTION GROUP FOR ITH MATRIX.
    5 READ 100,(MATWDGR(I),I=1,NMATRIX)
C     MATWPERC(I)=PERSONNEL CATEGORY FOR ITH MATRIX.
      READ 100,(MATWPERC(I),I=1,NMATRIX)
      PRINT 202,(I,MATWDGR(I),MATWPERC(I),I=1,NMATRIX)
C
C     PARAMETERS TO DETERMINE AUTHORIZATIONS AND MANNING LEVELS
C     R(I)=FILL RATE FOR ITH DISTRIBUTION-PRIORITY GROUPING.
      N=NOPRGRP*NODISGR
      READ 101,(R(I),I=1,N)
      NOAUTH=NODISGR*NPERCAT*NOPRGRP
      READ 100,(AUTH(I),I=1,NOAUTH)
      READ 100,(NEWAUTH(I),I=FIRST,LAST)
C     NEWAUTH VECTOR CONTROLS INPUT OF NEW AUTHORIZATIONS.  IF NEWAUTH(I)
C          =0, PREVIOUS AUTHORIZATOONS ARE USED.
C          =1, NEW AUTHORIZATIONS ARE READ.
      M=L=0
      PRINT 203
      DO 10 I=1,NODISGR
      DO 10 J=1,NPERCAT
      M=0
      DO 10 K=1,NOPRGRP
      L=L+1
      M=M+1
   10 PRINT 204,I,J,K,AUTH(L),R(M)
      RETURN
C
C
C     SECTION 2
C     ENTRY AVAIL CALCULATES THE NUMBER OF PERSONNEL AVAILABLE FOR REASSIGN-
C         MENT TO THE FOLLOWING DISTRIBUTION GROUPINGS-
C            NOS=CONUS ONLY (NOT OVERSEAS)
C            NST=CONUS AND LT (NOT SHORT TOUR)
C            IAV=CONUS,LT, AND ST(GENERAL DISTRIBUTION).
      ENTRY AVAIL
C
      NOS=NST=IAV=0
      IF(CIOS.LE.0) GO TO 11
      DO 12 I=1,CIOS
      IF(IOSDGR(I).EQ.1) NOS=NOS+IOS(I)
      IF(IOSDGR(I).EQ.2) NST=NST+IOS(I)
      IF(IOSDGR(I).EQ.3) IAV=IAV+IOS(I)
   12 CONTINUE
   11 DO 20 I=1,NMATRIX
      IUSE=2
```

```
      INTOT=0
      CALL SUMMARY(2,I,INTOT,IUSE,0)
      NOS=NOS+INTOT*PERNOS(I)
      NST=NST+INTOT*PERNST(I)
      IAV=IAV+INTOT*PERIAV(I)
      IF(INTOT*PERNOS(I)+INTOT*PERNST(I)+INTOT*PERIAV(I).LT.INTOT) IAV=
     1IAV+(INTOT-PERNOS(I)*INTOT-PERNST(I)*INTOT-PERIAV(I)*INTOT)
   20 CONTINUE
      PRINT 205, NOS,NST,IAV
      RETURN
C
C
C     SECTION 3
C     ENTRY AUTHOR GROUPS AUTHORIZATIONS INPUT BY DISTRIBUTION GROUP,
C         PERSONNEL CATEGORYS,AND PRIORITY GROUP,ACCORDING TO DISTRIBUTION
C         GROUP AND PRIORITY GROUP.  IT USES SUBROUTINE PREPARE.
C
C     PRAUTH(I,J)=AUTHORIZATIONS FOR ITH PRIORITY GROUP WHICH CAN BE FILLED
C         BY THE JTH DISTRIBUTION GROUP PERSONNEL.
      ENTRY AUTHOR
C     IF INITIAL.LE. 1. NEW AUTHORIZATIONS ARE READ FOR THIS TIME PERIOD.
C         OTHERWISE,AUTHORIZATIONS ARE THE SAME AS THE PREVIOUS TIME PERIOD.
C
      INITIAL =2
      CALL PREPARE(INITIAL,NPERCAT,NOPRGRP,NODISGR)
      RETURN
C
C
C
C     SECTION 4
C     ENTRY ASSET SUMMARIZES ASSETS FROM MATRICES ACCORDING TO DISTRIBUTION
C         GROUPS,COLLAPSING OVER PERSONNEL CATEGORIES.
      ENTRY ASSET
C
C     ASSETS(I)=PERSONNEL CURRENTLY SERVING IN ITH MATRIX.
C
      DO 40 I=1,NODISGR
      DGRASSET(I)=0
      DO 40 J=1,NOPRGRP
   40 PRASSET(J,I)=0
C       PRASSETS(I,J)=ASSETS FOR JTH PRIORITIES WITHIN ITH DISTRIBUTION GROUPS.
C
      DO 45 I=1,NMATRIX
      J=MATWDGR(I)
      DGRASSET(J)=DGRASSET(J)+ACTUAL(I)
   45 ASSETS(I)=ACTUAL(I)
      PRINT 207,(J,DGRASSET(J),J=1,NODISGR)
      RETURN
C
C
C     SECTION 5
C     ENTRY DISTR DISTRIBUTES ASSETS AMONG PRIORITY GROUPS WITHIN EACH
C          DISTRIBUTION GROUP.
      ENTRY DISTR
      DO 50 I=1,NODISGR
      NEWIP=DGRASSET(I)
      IF(NEWIP.LE.0) GO TO 50
      LIMITED=1
      JPR=I*NOPRGRP
      IDIS=I
      NODIS=1
C      NEWIP=PERSONNEL TO BE DISTRIBUTED
```

```
C      NODIS=NUMBER OF DISTRIBUTION GROUPS TO BE CONSIDERED.
C      IDIS=FIRST DISTRIBUTION GROUP TO BE CONSIDERED.
      IOVER=0
C     DISTRIBUTE AVAILABLE PERSONNEL UP TO AUTHORIZATION LEVELS.
      CALL ALLOT(NEWIP,IDIS,NOPRGRP,NODIS,IOVER)
   50 CONTINUE
      DO 55 I=1,NAVCAT
      IF(I.LE.1) NEWIP=NOS
      IF(I.EQ.2) NEWIP=NST
      IF(I.GE.3) NEWIP=IAV
      IF(NEWIP.LE.0) GO TO 55
      IOVER=0
      IDIS=NAVCAT-I+1
      NODIS=I
      LIMITED=1
      CALL ALLOT(NEWIP,IDIS,NOPRGRP,NODIS,IOVER)
   55 CONTINUE
      IF(IOVER.LE.0) GO TO 58
C     DISTRIBUTE EXTRA PERSONNEL TO CONUS.
      IDIS=NODISGR
      NODIS=1
      NEWIP=IOVER
      IOVER=0
      LIMITED=0
      CALL ALLOT(NEWIP,IDIS,NOPRGRP,NODIS,IOVER)
   58 CONTINUE
      RETURN
C
C
C     SECTION 6
C     ENTRY GMMANLEV TOTALS MANNING LEVELS ACROSS PRIORITY GROUPS WITH
C          DISTRIBUTION GROUPS.  THE TOTALS ARE SET EQUAL TO THE VARIABLE NEEDS.
      ENTRY GMMANLEV
C
      K=0
      DO 65 I=1,NODISGR
      DGRMAN=0.0
C     DGRMAN=DISTRIBUTION GROUP MANNING LEVEL.
      DO 64 J=1,NOPRGRP
      K=K+1
   64 DGRMAN=DGRMAN+MANLEV(K)
   65 NED(I)=NEEDS(I)=DGRMAN
      PRINT 209,(I,NEEDS(I),I=1,NODISGR)
      DO 66 I=1,NMATRIX
      J=MATWDGR(I)
      NEEDS(J)=NEEDS(J)-ASSETS(I)
      IF(NEEDS(J).LT.0) NEEDS(J)=0
   66 CONTINUE
      PRINT 210,(I,NEEDS(I),I=1,NODISGR)
      RETURN
C
C
C     SECTION 7
C     ENTRY DATASTOR CALCULATES AND STORES TOTALS OF ASSETS AND TRANSIENTS BY
C          DISTRIBUTION GROUP AND PERSONNEL CATEGORIES.
      ENTRY DATASTOR
C
      L=NODISGR*NPERCAT
      N=NODISGR*NPERCAT
      DO 74 I=1,N
```

```
   74 ITRAN(I)=IACTIVE(I)=0
C
      DO 75 I=1,NMATRIX
C     READ ITH MATRIX AND SUM ASSETS.
      ITRANS=IACTUAL=IREAD=0
      IUSE=1
      CALL SUMMARY(1,I,IACTUAL,IUSE,IREAD)
C
      IUSE=3$IREAD=1
C     SUM TRANSIENTS IN ROW 1 AND COLUMNS 1 TO MAXLEN OF THE ITH  MATRIX.
      CALL SUMMARY(1,I,ITRANS,IUSE,IREAD)
C
C     TOTAL ASSETS AND TRANSIENTS BY DISTRIBUTION GROUP AND PERSONNEL CATEGORY.
      J=MATWDGR(I)*NPERCAT-NPERCAT+MATWPERC(I)
      IACTIVE(J)=IACTIVE(J)+IACTUAL
   75 ITRAN(J)=ITRAN(J)+ITRANS
C
C     STORE TOTALS OF ASSETS AND TRANSIENTS ON LU 14.
      K=INTEG*2-1
      CALL RANWRITE(14,IACTIVE,L,K)
      K=K+1
      CALL RANWRITE(14,ITRAN,L,K)
      PRINT 211,K,(I,IACTIVE(I),ITRAN(I),I=1,L)
      RETURN
C
C
C     SECTION 8
C     ENTRY OUTPUTD READS STORED DISTRIBUTION DATA AND OUTPUTS IT IN A MODIFIED
C          TABULAR FORM.
      ENTRY OUTPUTD
C
C
      IPER=1
      L=NODISGR*NPERCAT
      DO 80 I=1,L
      ASSETS(I)=ACTUAL(I)=0
   80 IACTIVE(I)=ITRAN(I)=0
      PRINT 212
      DO 90 I=FIRST,LAST
      K=I*2-1
      CALL RANREAD (14,IACTIVE,L,K)
      K=K+1
      CALL RANREAD(14,ITRAN,L,K)
C     COLLECT ASSETS(IACTIVE) AND TRANSIENTS(ITRAN( WITHIN DISTRIBUTION-
C          PERSONNEL CATEGORIES INTO SPECIFIED OUTPUT TIME INTERVALS(IPERIOD).
      DO 81 J=1,L
      ASSETS(J)=ASSETS(J)+IACTIVE(J)
   81 ACTUAL(J)=ACTUAL(J)+ITRAN(J)
      PRINT 217,(J,ASSETS(J),ACTUAL(J),J=1,L)
      IOUTPER=I/IPERIOD
      XI=I
      XIPERIOD=IPERIOD
      XOUTPER=XI/XIPERIOD
      PRINT 218,IOUTPER,XOUTPER
      IF(IOUTPER.NE.XOUTPER) GO TO 90
C     SPREAD ASSETS(ASSETS) AND TRANSIENTS(ACTUAL) AMONG PRIORITY GROUPS
C          AND OUPTUT FOR IPER TIME BLOCK.
      PRINT 213,IPER
      ICAT=0
      DO 88 J=1,NODISGR
      PRINT 214,J
      PRINT 215
```

```
      DO 88 K=1,NPERCAT
      ITER=0
   82 IF(ITER.GE.1) GO TO 83
      ICAT=ICAT+1
      NEWIP=ASSETS(ICAT)
   83 IDIS=J
      NODIS=1
      LIMITED=0
      IOVER=0
      DO 84 KK=1,NOPRGRP
   84 PRASSET(KK,J)=0
      IF(NEWIP.LE.0) GO TO 91
      CALL ALLOT(NEWIP,IDIS,NOPRGRP,NODIS,IOVER)
C     NE(10,10) IS USED TO TEMPROARILY STORE DISTRIBUTED ASSETS WHILE TRANSIENTS
C          ARE BEING DISTRIBUTED.
   91 IF(ITER.GE.1) GO TO 86
      DO 85 KK=1,NOPRGRP
   85 PRACTIVE(KK,J)=PRASSET(KK,J)
      ITER=ITER+1
      NEWIP=ACTUAL(ICAT)
      GO TO 82
   86 DO 87 ICOM=1,NOPRGRP
      XPRAUTH=PRAUTH(ICOM,J)
      PERFILL=PRACTIVE(ICOM,J)/XPRAUTH
      ISHORT=XPRAUTH-PRACTIVE(ICOM,J)
   87 PRINT 216,K,ICOM,PRAUTH(ICOM,J),PRACTIVE(ICOM,J),PERFILL,ISHORT,PR
     1ASSET(ICOM,J)
   88 CONTINUE
      IPER=IPER+1
      DO 89 J=1,L
      ASSETS(J)=ACTUAL(J)=0
   89 IACTIVE(J)=ITRAN(J)=0
   90 CONTINUE
      RETURN
C
C
C     SUBROUTINE DISTRO2 FORMATS
  100 FORMAT(8I10)
  101 FORMAT(8F10.3)
  200 FORMAT(24H0DISTRIBUTION PARAMETERS//31H0NO. OF DISTRIBUTION GROUPS
     1  = I3/31H0NO. OF PERSONNEL CATEGORIES = I3/31H0NO. OF PRIORITY GR
     1OUPS       = I3/31H0NO. OF MATRICES SIMULATED    = I3 /31H0NO. OF AV
     1AILABILITY CAT.     = I3)
  201 FORMAT(43H0MATRIX   PERCENT OF AVAILABLE ELIGIBLE FOR/10X,33HCONUS
     1 ONLY   CONUS,LT   CONUS,LT,ST/13X,5H(NOS),5X,5H(NST), 7X,5H(TAV)//
     1(I5,F12.3,F11.3,F12.3))
  202 FORMAT(/47H0MATRIX  DISTRIBUTION GROUP  PERSONNEL CATEGORY/(I5,I12
     1,I23))
  203 FORMAT(/56H0DISTRIBUTION  PERSONNEL  PRIORITY  AUTHORIZATION   FIL
     1L/36H    GROUP         CATEGORY     GROUP    15X,6HRATIO /)
  204 FORMAT(I7,I13,I11,I14,F12.3)
  205 FORMAT(//40H0PERSONNEL AVAILABLE FOR DISTRIBUTION TO/21H0CONUS
     1          = ,I5/21H0CONUS AND LT       = , I5/21H0CONUS, LT, AND ST
     1= ,I5)
  206 FORMAT(18H0ASSETS FOR MATRIX,I4,3H = ,I5/(18X,I4,3H = ,I5))
  207 FORMAT(28H0DISTRIBUTION GROUP    ASSETS/(I14,8X,I6))
  208 FORMAT(/20H0INPUT GROUP      DISTR. GROUP/(I7,10X,I6))
  209 FORMAT(12H0DISTR. GRP.,3X,13HMANNING LEVEL/(I8,I16))
  210 FORMAT(12H0DISTR. GRP.,3X,12HNEEDED INPUT/(I8,I16))
  211 FORMAT(30H0DATA STORED FOR DISTRO PERIOD,I3/26H0GROUP   ACTIVE   TRA
     1NSIENTS/(I5,I9,I12))
```

```
212 FORMAT(//27X,25HDISTRIBUTION DATA SUMMARY//)
213 FORMAT( 33X,10HTIME BLOCK,I3)
214 FORMAT( /19HODISTRIBUTION GROUP,I3)
215 FORMAT(/49HOPERSONNEL   COMMAND    NUMBER    MANNING  PERCENT/72HOC
   1ATEGORY   ELEMENT  AUTHORIZED   LEVEL     FILL   SHORTFALL  TRANSI
   1ENTS)
216 FORMAT(I7,I10,I8,F11.3,F10.3,I10,F11.3)
217 FORMAT(22HOMATRIX  ACTIVE  ITRAN/(I5,I9,I7))
218 FORMAT(10HOIOUTPER =,I3,10HXOUTPER = F3.2)
    END
```

FORTRAN DIAGNOSTIC RESULTS FOR DISTRO2

VARIABLES WHICH APPEAR ONLY IN A TYPE STATEMENT
SUMAUTH MENUSED

NULL STATEMENT NUMBERS
206

```
      SUBROUTINE ALLOT(NEWIP,IDIS,NOPRGRP,NODIS,IOVER)
C
C       3 NOVEMBER 1969.  PROGRAMMER WITT
C       SUBROUTINE ALLOT DISTRIBUTES ASSETS TO PRIORITY GROUPS.
      COMMON        IP         ,INE(48)   ,IFND      ,JK        ,SYST(48,48)
      COMMON        ITRTIME    ,NOTR(10)  ,LENGTH(100)          ,OUT(100)
      COMMON        TRINT(100),TRINS(100)           ,TROUTT(100)
      COMMON        TROUTS(100)           ,FSTROWO(100)         ,LSTROWO(100)
      COMMON        FSTCOLO(100)          ,LSTCOLO(100)         ,FSTROWI(100)
      COMMON        FSTCOLI(100)          ,PCTOUT(100)          ,PCTIN(100)
      COMMON        NEEDS(30),NE(30,10),NSTT(30), INOS(10,10)             10FEB 71
      COMMON        INTOUR(50),           INSUB(50),OUTTOUR(50)           6 JAN 71
      COMMON        OUTSUB(50),           AFTER(50),PER(50),   PEROUT(50) 6 JAN 71
      COMMON        REP(50),   IOD(50),   IGRADE(50),          ITYPE(50)  6 JAN 71
      COMMON        IOS(10)    ,NED(30)   ,NFE(100)  ,IFILL     ,MAXLEN   10FEB 71
      COMMON        NTOUR      ,NP        ,CIOS      ,SYS(48,48)
      COMMON        PDW        ,LSTRSTO(10)          ,LSTRSTT(10)
      COMMON        LSTRSTS(10)           ,ITT       ,MAXSUB    ,ACT(30)  10FEB 71
      COMMON        IDISTON    ,ISUM      ,GRPSUM(100)
      COMMON        BEGROW(100)           ,ENDROW(100)          ,BEGCOL(100)
      COMMON        ENDCOL(100)           ,MATSUM(100)          ,MATGRPS(100)
      COMMON        TYPE(100),SUB(100)    ,NUM(100)  ,ACTUAL(100)
      COMMON        NPRLEV     ,NT        ,IHOLD     ,LEN       ,LEVEL     ,M
      COMMON        NCRNODE(100)          ,MIN(100)  ,GRPINPR(100)
      COMMON        INTEG      ,NOTT      ,FIRST     ,LAST      ,IPRINT   26FEB71
C     FOLLOWING COMMON STATEMENTS USED ONLY IN ASSET,PREPARE, AND ALLOT
      COMMON        AUTH(100) ,PRAUTH(10,10)        ,ASSETS(100)
      COMMON        MATWDGR(100)          ,R(100)    ,PRASSET(10,10)
      COMMON        DGRASSET(100)         ,PERNOS(100)          ,PERNST(100)
      COMMON        PERIAV(100)           ,MATWPERC(100)
      COMMON        FILL(100) ,MANLEV(100)          ,NEWIN(100),
      COMMON        LIMITED    ,IOSDGR(100)          ,NEWAUTH(100)
      COMMON        DGRAUTH(100)          ,MANDGR(100)          ,NAVCAT
      COMMON        RAT(100)   ,SUMAUR(100)          ,SUMASS(100)
      INTEGER       TYPE       ,SUB       ,ACTUAL    ,ENDCOL    ,SYS
      INTEGER       CIOS       ,SYST      ,OUTSUB    ,OUTTOUR   ,AFTER
      INTEGER       ACT        ,FIRST     ,GRPSUM    ,BEGROW    ,ENDROW
      INTEGER       BEGCOL     ,TRINT     ,TRINS     ,TROUTT    ,TROUTS
      INTEGER       FSTROWO    ,FSTCOLO   ,FSTROWI   ,FSTCOLI
      INTEGER       AUTH       ,PRAUTH    ,ASSETS               ,DGRASSET
      INTEGER       FIRST      ,DGRAUTH   ,SUMAUTH   ,FILL
      REAL          MENUSED    ,MANLEV
C
      N=NODIS*NOPRGRP
      ISTART=IDIS*NOPRGRP-NOPRGRP+1
      ISTOP=ISTART+N-1
      PRINT 102,N
      IF(LIMITED.EQ.1) PRINT 103
C
C       N=TOTAL NUMBER OF PRIORITY GROUPS TO WHICH ASSETS ARE DISTRIBUTED.
C       AUTH(I)=AUTHORIZATIONS FOR PRIORITY GROUP I.
C       ASSETS(I)=ACTUAL CURRENTLY SERVING IN GROUP I.
C       R(I)=GROUP I RATIO
C       LIMITED.  IF=1,FILL GROUPS USING AUTHORIZATIONS AS UPPER LIMIT.
C           IF=2,FILL GROUPS WITH ALL AVAILABLE PERSONNEL.
C       NEWIP=NEW AVAILABLE INPUT.
C
C       OBTAIN SUMMARY STATISTICS
```

```
      SUMAUTH=ITER=0
      PRINT 100,(I,PRAUTH(I),PRASSET(I),I=1,30)
      LDIS=IDIS+NODIS-1
      I=ISTART-1
      DO 2 J=IDIS,LDIS
      TOTASS=TOTAUR=0
C     CALCULATE SUMS OF ASSETS AND AUTHORIZATIONS*RATIOS FOR JTH DISTRIBUTION GR
      RAT(J)=0.0
      SUMAUTH=SUMAUR(J)=SUMASS(J)=0
      DO 1 K=1,NOPRGRP
      I=I+1
      FILL(I)=0
      SUMAUTH=SUMAUTH+PRAUTH(K,J)
      SUMAUR(J)=SUMAUR(J)+PRAUTH(K,J)*R(I)
    1 SUMASS(J)=SUMASS(J)+PRASSET(K,J)
      PRINT 106, SUMAUTH,SUMAUR(J),SUMASS(J),TOTASS
C
      IF(SUMASS(J).LE.0) PRINT 101,RAT(J)
C     CALCULATE TOTAL NUMBER OF ASSETS AND AUTH*RATIOS FOR ENTIRE SYSTEM.
      TOTASS=TOTASS+SUMASS(J)
    2 TOTAUR=TOTAUR+SUMAUR(J)
      I=0
      PRINT 106,I,TOTAUR,TOTASS,NEWIP
      TOT=TOTASS+NEWIP$TOTA=TOTAUR
      IF(TOT.LE.0) GO TO 41
C
    3 RATIO=TOT/TOTA
      PRINT 108,RATIO
      IRUN=1
      DO 4 J=IDIS,LDIS
      IF(RAT(J).NE.0.0) GO TO 4
      IF(SUMASS(J).GT.0.0) GO TO 7
      RX=0.0
      GO TO 8
    7 RX=SUMASS(J)/SUMAUR(J)
    8 IF(RX.LT.RATIO) GO TO 4
C     WHEN RAT(J).GT.RATIO,SET RAT(J)=SUMASS(J)/SUMAUR(J).
      RAT(J)=RX
      TOT =TOT-SUMASS(J)
      TOTA=TOTA-SUMAUR(J)
      IRUN=2
    4 CONTINUE
C
      GO TO(5,3),IRUN
    5 DO 6 J=IDIS,LDIS
C
C     WHEN RAT(J).LT.RATIO,SET RAT(J)=RATIO.
      IF(RAT(J).EQ.0.0) RAT(J)=RATIO
    6 CONTINUE
      PRINT 111,(J,RAT(J),J=IDIS,LDIS)
C
C      MINIMUM ASSIGNED TO  GROUP(I)=ASSETS.  IF LIMITED=1,MAXIMUM ASSIGNED
C           TO GROUP(I)=AUTH(I).  OTHERWISE,UPPER LIMIT=F(AVAILABLE PERSONNEL).
      PRINT 108,RATIO
      MENUSED=0
C
      ITER=ITER+1
      I=ISTART-1
      DO 15 J=IDIS,LDIS
      DO 15 K=1,NOPRGRP
      I=I+1
      IF(FILL(I).EQ.1) GO TO 15
```

```
      A=PRAUTH(K,J)
      MANLEV(I)=RAT(J)*R(I)*A
      PRINT 109,I,MANLEV(I)
      IF(MANLEV(I).LT.PRASSET(K,J)) GO TO 12
      IF(MANLEV(I).LT.PRAUTH(K,J)) GO TO 14
      IF(LIMITED.EQ.1) MANLEV(I)=PRAUTH(K,J)
      PRINT 109,I,MANLEV(I)
      IF(MANLEV(I).LT.PRASSET(K,J)) GO TO 12
      FILL(I)=1
      GO TO 14
   12 MANLEV(I)=PRASSET(K,J)
      FILL(I)=1
   14 MENUSED=MENUSED+MANLEV(I)
   15 CONTINUE
      PRINT 107,ITER,MENUSED
      PRINT 110,TOT
C
C      CHECK FOR ROUNDING ERRORS
      IF(TOT   .EQ.MENUSED) GO TO 30
      IF(TOT   .LE.MENUSED) GO TO 17
      PRINT 110,TOT
      PRINT 107,ITER,MENUSED
C
   17 NFILL=0
      IF(LIMITED.EQ.0) GO TO 24
      PRINT 107,ITER,MENUSED
      I=ISTART-1
      DO 20 J=IDIS,LDIS
      DO 20 K=1,NOPRGRP
      I=I+1
      NFILL=NFILL+FILL(I)
      IF(FILL(I).NE.1) GO TO 20
      A=PRAUTH(K,J)
      TOTA=TOTA-A*R(I)
      TOT=TOT-MANLEV(I)
   20 CONTINUE
C
      IF(TOT   .LE.0) GO TO 30
      IF(NFILL.GT.0.AND.NFILL.LT.N) GO TO 3
      IF(NFILL.EQ.N.AND.TOT   .EQ.MENUSED) GO TO 30
   24 TOT   =TOT   -MENUSED
      ITOT=TOT
      DO 25 I=1,ITOT
   25 MANLEV(I)=MANLEV(I)+1
   30 IOVER=TOT   -MENUSED
C
      PRINT 104
      I=ISTART-1
      DO 40 J=IDIS,LDIS
      DO 40 K=1,NOPRGRP
      I=I+1
      NEWIN(I)=MANLEV(I)-PRASSET(K,J)
      IF(NEWIN(I).LT.0) NEWIN(I)=0
C
      IF(MANLEV(I).GT.PRASSET(K,J)) PRASSET(K,J)=MANLEV(I)
   40 PRINT 105,(I,R(I),PRAUTH(K,J),MANLEV(I),PRASSET(K,J),NEWIN(I))
   41 CONTINUE
C
C      SUBROUTINE ALLOT FORMATS.
  100 FORMAT(2I10,F10.3)
  101 FORMAT(8F10.4)
```

```
102 FORMAT(29H0NUMBER OF PRIORITY GROUPS = ,I2)
103 FORMAT(43H0AUTHORIZATIONS SERVE AS GROUP UPPER LIMITS)
104 FORMAT(69H0PR.GRP.   RATIO   AUTHORIZATION   MANNING LEVEL   ASSET
   1S   NEW INPUT)
105 FORMAT(I4,7X,F6.3,3X,I9,6X,F10.3,F11.3  ,4X,I6)
106 FORMAT(27H0TOTAL NUMBER AUTHORIZED = I6,/26H0TOTAL AUTHORIZED*RATI
   1O = F10.3/34H0TOTAL NUMBER OF CURRENT ASSETS = F10.3/27H0TOTAL TO
   1BE DISTRIBUTED = F10.3)
107 FORMAT(13H0ITERATION = I3/22H0NUMBER DISTRIBUTED = F6.2)
108 FORMAT (9H0RATIO = F5.3)
109 FORMAT(12H0PR. GRP. = I4,5X,17H MANNING LEVEL = F6.2)
110 FORMAT(10H0TOTASS = F10.3)
111 FORMAT(25H0DISTR. GRP.   FILL RATIO/(I7,7X,F7.3))
      END

            FORTRAN DIAGNOSTIC RESULTS  FOR    ALLOT

NO ERRORS
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